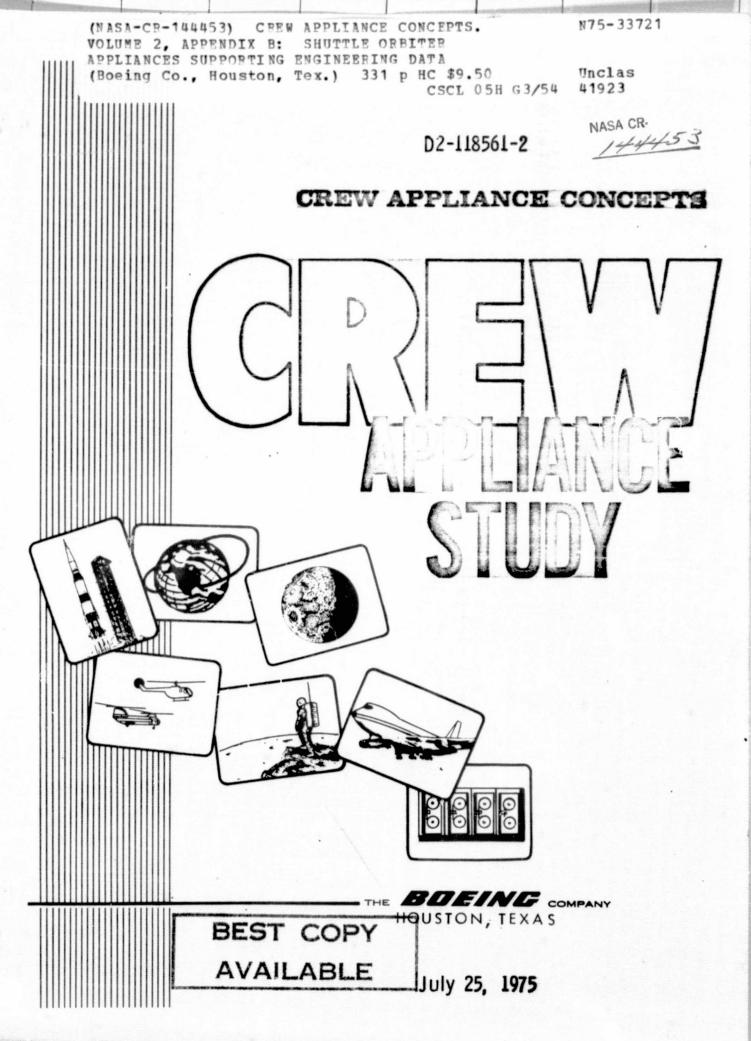
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TITLE CREW APPLIANCE CONCEPTS

Contract NAS 9-13965

July 18, 1975

Prepared by

B. W. Proctor R. P. Reysa D. J. Russell

CREW APPLIANCE CONCEPTS

APPENDIX B

SHUTTLE ORBITER APPLIANCES
SUPPORTING ENGINEERING DATA

PREFACE

A study of crew appliances for advanced spacecraft is being performed for NASA JSC by the Boeing Aerospace Company under Contract NAS 9-13965. A large number of appliance concepts for the galley, personal hygiene, housekeeping, and other areas have been investigated for application to the Shuttle Orbiter and Modular Space Station missions. This document presents the background to and results of trade studies to determine the optimum appliance systems for these two vehicles.

An index file containing abstracts for 299 appliance-related documents was developed during the initial literature search for this study. The original file will be delivered to and retained by NASA.

Due to the large volume of library references and appliance engineering data used for the trade studies, it was necessary to present the supporting information to the concept report in separate appendices as follows:

- APPENDIX A In this appendix, the complete bibliography used for the appliance study is listed in three forms: numbered, alphabetized, and sorted by subject matter.
- APPENDIX B This appendix contains the supporting engineering data used for all appliance concepts considered for Shuttle Orbiter, including plotted and tabulated trade study results for each appliance function.

APPENDIX C - This appendix contains the supporting engineering data used for all appliance concepts considered for Modular Space Station, including plotted and tabulated trade study results for each appliance function.

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1.0 INTRODUCTION

A large number of crew appliance concepts have been studies for applicability to the Modular Space Station and Shuttle Orbiter spacecraft, and detailed trade studies of the various concepts were conducted to choose the optimum appliance systems for both vehicles. Due to the volume of data used for the appliance trade studies, it was necessary to present the supporting information to the concept report in separate appendices. In this appendix are included all the engineering data collected for the appliances considered for Shuttle Orbiter, as well as plotted and tabulated trade study results for each appliance function.

A crew appliance system organization chart was constructed, Figure B1-1, to thoroughly and orderly establish an appliance system. The appliance concepts considered for Shuttle Orbiter were categorized within this system as listed in Figure B1-2. The engineering data and trade study results for the appliance concepts evaluated are presented in this appendix in the order given in Figure B1-2. All the appliance data apply to a four-man mission, with the baseline mission ground rules and assumptions given in Figure B1-3. The basic mission considered for Shuttle Orbiter was 20.5 days. The Shuttle Orbiter timeline used is illustrated in Figure B1-4.

The data used for trading alternate appliance concepts are presented in Section 2 of this appendix. The format used in the data presentation is as follows:

<u>Top Sheet Description</u>. This data sheet gives a description of the appliance function with the assumptions made for computing appliance size and penalties.

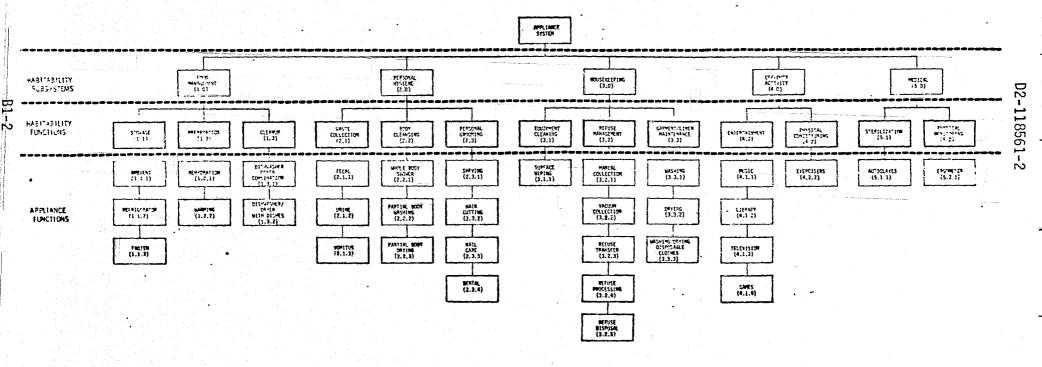


Figure B1-1. Crew Appliance System Organization

1.0	FOOD MANAGEMENT		Ultrasonic Wash - Centrifuge Drying Ultrasonic Wash - Forced Hot Air
1.1	FOOD STORAGE		Electric Dry
1.1.1	Ambient Food Storage	1.3.1.8	Ultrasonic Wash - Force Cold Dry Air - Desiccant, Electrically Desorbed
1.1.1.1	Rigid Containers	1.3.1.9	Ultrasonic Wash - Force Hot Air Dry -
1.1.1.2	Flexible Containers	1.3.1.10	Thermal Storage Manual Wash - Manual Wipe Dry
1.1.2	Refrigerated Food Storage	1.3.2	Dishwasher/Dryer with Dishes
1.1.2.1 1.1.2.? 1.1.2.3	Space Radiator Thermoelectric Air Cycle Turbine/Compressor		Hot Water Spray - Centrifuge Drying Hot Water Spray - Forced Hot Air Electric Heat Drying
1.1.3	Frozen Food Storage	1.3.2.3	Hot Water Spray - Forced Air/Desiccant/
1.1.3.2	Space Radiator Thermoelectric Air Cycle Turbine/Compressor		Electrically Heated Manual Wash - Manual Wipe Disposable Cups - Reusable Metallic Utensils and Dishes
1.2	FOOD PREPARATION	1.3.2.6	Disposable Cups and Nonmetallic Dishes - Reusable Metallic Utensils
1.2.1	Food Rehydration	1.3.2.7	Disposable Cups and Nonmetallic Utensils - Reusable Metallic Dishes
1.2.2	Food Warming	1.3.2.8	Disposable Cups and Nonmetallic Utensils and Dishes
1.2.2.2	Heating Trays (Skylab) Oven - Hot Air Convention (Electric Heat) Oven - Microwave		Reusable Cups and Metallic Utensils and Dishes
	Over - Microwave	1.3.2.10	Reusable Cups and Metallic Utensils - Disposable Nonmetallic Dishes
1.3	GALLEY CLEANUP	1.3.2.11	Reusable Cups and Metallic Dishes -
1.3.1	Dishwasher/Dryer Combination	1.3.2.12	Disposable Nonmetallic Utensils Reusable Cups-Disposable Nonmetallic
	Hot Water Spray - Centrifuge Drying Hot Water Spray - Air Spray Dry		Utensils and Dishes
	Hot Water Spray Wash - Force Hot Air Electric Heat Dry	2.0	PERSONAL HYGIENE
1.3.1.4	Hot Water Spray Wash - Forced Cold Air Desiccant	2.1	WASTE COLLECTION/TRANSFER
1.3.1.5	Hot Water Spray Wash - Forced Hot Air Dry - Thermal Storage	2.1.1	Fecal Collection/Transfer
	Sign inclinationage		

Figure B1-2. Crew Habitability and Appliance Functions and Concepts



Figure B1-2. Crew Habitability and Appliance Functions and Concepts (continued)

3.1.1.3	Reusable Wet/Disposable Dry Wipes Disposable Wet/Dry Wipes (Prepackaged) Automatic Mop Reusable Cleaning Cloths/ Disposable Dry	3.2.5.3	Storage Bin/Container Restorage/Biological Stabilized Trash Rocket
	Wipes	3.3	GARMENT/LINEN MAINTENANCE
	Disposable Cleaning Cloths/Disposable Dry Wipes	3.3.1	Garment/Linen Washing
3.1.1.8 3.1.1.9 3.1.1.10	Disposable Wet Wipes/Reusable Dry Wipes Reusable Wet/Dry Wipes Reusable Cleaning Cloths/Dry Wipes Disposable Cleaning Cloths/Reusable Dry Wipes	3.3.1.2 3.3.1.3 3.3.1.4	Mechanical Oscillations Fluidic Agitation Piston Agitation Cyclic Valve and Pump Diaphragm Actuated - One Directional
3.1.1.11 3.1.1.12	Sponges Sponges/Skylab Wetting Unit		Squeeze
	REFUSE MANAGEMENT	3.3.1.6	Diaphragm Actuated - Two Directional Squeeze
3.2.1	Manual Collection		Water Spray Agitated Ultrasonic
	Waste/Trash Bags Waste Receptacles/Reusable		Manual Washboard Plain Recirculation
3.2.1.3	Waste Receptacles/Disposable	3.3.2	Garment/Linen/Drying
3.2.2	Vacuum Collection		Forced Hot Air - Electric
	Portable Vacuum/Electric (Skylab) Portable Vacuum/Electric (Commercial)		Forced Hot Air - Heat from Thermal Storage Unit
3.2.2.3	Portable Vacuum/Space Venting	3.3.2.3	Force Cold Dry Air - Desiccant - Vacuum Regenerable
3.2.3 3.2.4	Refuse Transfer Refuse Processing	3.3.2.4	Force Cold Dry Air - Desiccant - Heat Regenerable
	Compactor		Vacuum Dry
3.2.4.2 3.2.4.3	Shredder Incinerator		Thermal Vacuum Dry - Electric Heat Thermal Vacuum Dry - Thermal Storage/ Radiant Heat
3.2.4.5	Integrated Vacuum Decomposition Flush Flow O2 Incineration Pyrolysis/Batch Incineration Wet Oxidation		Clothesline - Forced Convection Clothesline - Forced Convection plus Electric Heat
3.2.5	Refuse Disposal/Storage	3.3.3	Garment/Linen Washer/Dryer-Disposable Clothes
3.2.5.1	Vacuum Storage	3.3.3.1	Fluidic Agitation/Forced Hot Air - Electric Heater

Figure B1-2. Crew Habitability and Appliance Functions and Concepts (continued)

	그는 본 경우들이 많아 가입니다. 그는 것이 그리고 그리고 그렇게 되는 그 그 사람들이 하는 것이 그리고 되었다.
3.3.3.2	Fluidic Agitation/Forced Hot Air = Thermal Storage Heated
3.3.3.3	
3.3.3.4	Fluidic Agitation/Forced Air Drying - Clothesline
3.3.3.5	Water Spray Agitation/Forced Hot Air - Electric Heater
3.3.3.6	Water Spray Agitation/Forced Hot Air - Thermal Storage Heater
3.3.3.7	Water Spray Agitation/Forced Air Drying - Clothesline
3.3.3.8	-Water Spray Agitation/Electrically Heated - Clothesline
3.3.3.9	Disposable Clothes
3.4	WASH WATER PROCESSING
4.0	OFF-DUTY ACTIVITIES
4.1	ENTERTAINMENT
4.1.1	<u>Music</u>
4.1.1.1	Cassette Player/Recorder
4.1.2	Library
4.1.2.1	Books
4.1.3	<u>Television</u>
4.1.4	Games
4.1.4.1	
4.1.4.2 4.1.4.3	Dart Board Cards
4.2	PHYSICAL CONDITIONING
4.2 4.2.1	PHYSICAL CONDITIONING Exer-gym

4.2.2 Hand Exerciser

5.0 MEDICAL

5.1 STERILIZATION

5.1.1 Autoclaves

5.1.1.1 Moist Heat
5.1.1.2 Dry Heat
5.1.1.3 Ethylene Oxide

5.2 PHYSICAL MONITORING

5.2.1 Ergometer

Figure B1-2. Crew Habitability and Appliance Functions and Concepts (concluded)

SHUTTLE MISSION BASELINE

- o 150,000 POUND ORBITER
- o BASELINE MISSION
 - 42 MAN-DAYS (3-6 MALE/FEMALE CREW FOR 7 DAYS)
 - 4 MAN NOMINAL MISSION
- VEHICLE SYSTEM CAPABILITY
 - 42 MAN-DAYS + 96-HOUR CONTINGENCY FOR UP TO 10 CREWMEN (40 MAN-DAYS)

SHUTTLE IMPOSED REQUIREMENTS ON THE APPLIANCE SYSTEM

- o ALL MISSIONS WILL USE SAME HABITABILITY FUNCTIONS
- O GRAVITY ZERO TO ONE EARTH GRAVITY
- o ATMOSPHERE

- PRESSURE 14.7 PSIA
- COMPOSITION 3.2 PSIA 0₂
11.5 PSIA N₂

- CO₂ CONCENTRATION 0-7.6 mm Hg

- o TEMPERATURE
 - RANGE (DRY BULK) 60°-80° F
 4 MEN (DESIGN PT.) 70° F
 10 MEN (DESIGN PT.) 80° F
 DEWPOINT 39°-61° F
- o OPERATIONAL LIFE
 - 10 YEARS/100 ORBITAL MISSIONS/REPLACEABLE UNIT CONCEPT
- o GENERAL
 - GAS VENTING ALLOWED/NONPROPULSIVE
 - LIQUID VENTING SHALL BE MINIMIZED/NONPROPULSIVE
 - JETTISON OF SOLIDS/SOLID WASTES SHALL NOT BE ALLOWED.
 - NO MEDICAL SAMPLING REQUIRED OF FECES/URINE

SHUTTLE TIMELINE

SLEEP

O NOMINAL CREW TIMELINE (SEE FIGURE B1-4)

- WORK (INCLUDING OFF-DUTY) - 13 HOURS

- EAT

- 3 HOURS

REFERENCE MSC 07896, "SPACE SHUTTLE SYSTEM BASELINE REFERENCE MISSIONS-VOLUME II"

Figure B1-3. Shuttle Orbiter Baseline Mission

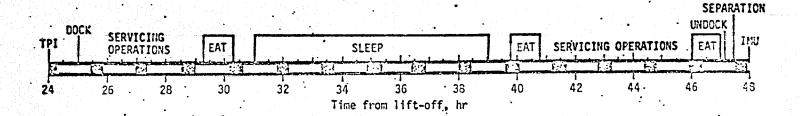
8 HOURS

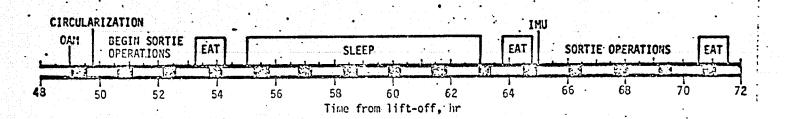
DARKNESS



PHASING 1ST COELLIPTIC 2ND CORRECTION COELLIPTIC 2ND COELLIPTIC 2ND CORRECTIVE COMBINATION EAT

O 2 4 6 8 10 12 14 16 18 20 22 24 Time from lift-off, hr





(a) Launch to 72 hours.

Figure B1-4. Shuttle Orbiter Timeline

1.0 (Continued)

<u>Appliance Function Matrix</u>. This table lists the following engineering data used for trading each appliance concept for a given appliance function:

- o Appliance usage time
- o Fluid consumables usage (e.g., amount of air or water lost to space)
- Fluid interface requirements (type of fluid, flow rate, temperature, pressure)
- o Thermal requirement for maximum heat leak to cabin atmosphere and directly to the coolant circuit
- o Average and peak AC and DC electrical power requirement
- o Appliance total weight/volume penalty
- o Development cost indicator based on state-of-the-art rating and concept complexity

The thermal, electrical, weight, and volume requirements listed in the table represent the total penalties assumed for the appliance and used to trade against alternate concepts. For example, the weight tabulated for reusable washcloths for partial body washing includes an appropriate weight charge for a clothes washer and dryer assumed to clean the cloths. To see the detailed itemized breakdown of each of these penalties, the data worksheets, described later, should be consulted.

Alternate Appliance Concept Rating Plots. In this figure is plotted the rating (based on zero minimum and 100 maximum points) for each appliance concept traded for a particular appliance function. These plots were



1.0 (Continued)

generated by the TRADE computer program described in the concept report. Higher ratings indicate a more favorable concept based on the penalties considered and the weighting factors assumed. A curve is given for each appliance function.

<u>Appliance Concept Selection Matrix</u>. Four tables are included here giving the results of the computer trade and sensitivity analysis. These tables include the following:

- o Selection matrix for a 20.5-day mission. This lists the weight, power, volume, etc. rating and the summed total points for each of the concepts. The total points are adjusted proportionally to a scale of zero to 100 maximum points to yield the final comparative rating for each concept.
- o Sensitivity analysis for a 20.5-day mission. This table lists the comparative rating for each appliance concept assuming the weighting factor for each trade parameter (e.g., weight, power, volume, etc.) is increased or decreased individually by 50 percent while holding all other weighting factors constant. Thus, the sensitivity of the above trade to any single weighting factor may be seen.

Component Reliability/Maintenance/Safety List. This table itemizes the types and number of components used for each appliance concept and the number of items considered to be safety critical. Each component is numbered to identify it in the component reliability list given in

1.0 (Continued)

Table B1-1. This list itemizes the reliability data used for each component in the computer selection trades.

<u>Appliance Concept Description</u>. Each concept is described verbally and a drawing presented where available.

Appliance Concept Data Worksheets. Two data sheets are included here which itemize the weight, volume, power, thermal, and consumables penalties associated with each appliance concept.

TABLE B1-1
COMPONENT FAILURE RATE AND REPAIR TIMES

COMPONENT COMPONENT REFERENCE (MITC) NUMBER N				EATLUSE DATE	 	DEDATE TIMES
NUMBER DESCRIPTION NUMBER MILLION HOURS NUMBER HRS/REPAIR	COMPONENT	COMPONENT	REFERENCE	FAILURE RATE (λ×10-6) FAILURES/	REFERENCE	REPAIR TIMES
2				MILLION HOURS		
2	1	MOTOR	2 52	3.8	- -	0.5+.2=.7
4 ACCUMULATOR 100 0.01 - 0.5+.2=.7 5 ACCUMULATOR/ 251 1.77 - 0.5+.4=.9 6 MATER SEPARATOR 100 1.20 254 0.2+.2=.4 7 TRANSMISSION 251 1.50 - 0.5+.1=.6 8 FLUIDIC SWITCH 251 1.61 - 1.0+.1=1.1 9 FILTER 251 0.16 - 0.2+.2=.3 10 ELECTRIC SWITCH 252 5.74 - 0.2+.1=.3 11 PRESSURE 100 2.94 254 0.1+.1=.2 REGULATOR 100 0.72 254 0.1+.2=.3 12 VALVE (GN ₂) 100 0.72 254 0.1+.2=.3 13 CONTROLLER 251 2.5 254 0.1+.3=.4 14 HIGH FREQUENCY CONTROLLER 251 2.5 254 0.1+.3=.4 14 HIGH FREQUENCY TRANSDUCER 251 0.23 254 0.2+.5=.7 17 HEATER-DC 251 1.0 - 0.2+.1=.3 18 BLOWER-AIR 251 10.89 254 0.2+.1=.3 19 CONTROLLER/ 251 2.5 254 0.1+.3=.4 19 CONTROLLER/ 251 2.5 254 0.1+.3=.4 19 CONTROLLER/ 251 10.89 254 0.2+.1=.3 19 CONTROLLER/ 251 2.5 254 0.1+.3=.4 11 TIMER 20 THERMAL STORAGE 251 0.23 - 0.2+.5=.7 21 DESICCANT 251 0.21 - 0.2+.5=.7 22 CHECK VALVE 251 0.312 - 0.1+.2=.3 24 TEMPERATURE 251 7.183 - 0.1+.2=.3 25 RELIEF VALVE 251 7.183 - 0.1+.2=.3 26 RF GENERATOR 252 .024 0.2+.5=.7	2	PUMP	100	6.0	254	
5 ACCUMULATOR/ BLADDER 6 WATER SEPARATOR 100 1.20 254 0.2+.2=.4 7 TRANSMISSION 251 1.50 - 0.5+.1=.6 8 FLUIDIC SWITCH 251 1.61 - 1.0+.1=1.1 9 FILTER 251 0.16 - 0.1+.2=.3 10 ELECTRIC SWITCH 252 5.74 - 0.2+.1=.3 11 PRESSURE 100 2.94 254 0.1+.1=.2 12 VALVE (GN₂) 100 0.72 254 0.1+.2=.3 13 CONTROLLER 251 2.5 254 0.1+.3=.4 14 HIGH FREQUENCY - UNK - UNK 15 ELECTROACOUSTIC 7.7 251 1.0 - 0.2+.5=.7 17 HEATER-DC 251 1.0 - 0.2+.1=.3 18 BLOWER-AIR 251 0.23 254 0.2+.1=.3 19 CONTROLLER/ 251 2.5 254 0.1+.2=.3 19 CONTROLLER/ 251 1.0 - 0.2+.1=.3 19 CONTROLLER/ 251 1.0 - 0.2+.1=.3 19 CONTROLLER/ 251 2.5 254 0.1+.3=.4 20 THERMAL STORAGE 251 0.23 - 0.2+.5=.7 21 DESICCANT 251 0.23 - 0.2+.5=.7 22 CHECK VALVE 251 0.312 - 0.2+.5=.7 23 MANUAL VALVE 251 0.312 - 0.1+.2=.3 24 TEMPERATURE 251 7.183 - 0.1+.2=.3 25 RELIEF VALVE 251 7.183 - 0.1+.2=.3 26 RF GENERATOR (MAGNETON TUBE) 27 ACTUATOR 252 .024 0.2+.5=.7	3	SOLENOID VALVE	100	0.72	254	0.1+.2=.3
BLADDER 6 WATER SEPARATOR 100 1.20 254 0.2+.2=.4 7 TRANSMISSION 251 1.50 - 0.5+.1=.6 8 FLUIDIC SWITCH 251 1.61 - 1.0+.1=1.1 9 FILTER 251 0.16 - 0.1+.2=.3 10 ELECTRIC SWITCH 252 5.74 - 0.2+.1=.3 11 PRESSURE 100 2.94 254 0.1+.1=.2 REGULATOR 251 2.5 254 0.1+.2=.3 12 VALVE (GN₂) 100 0.72 254 0.1+.2=.3 14 HIGH FREQUENCY - UNK - UNK 15 ELECTROACOUSTIC 252 86.2 254 0.1+.2=.3 16 HEAT EXCHANGER 251 0.23 254 0.2+.5=.7 17 HEATER-DC 251 1.0 - 0.2+.1=.3 18 BLOWER-AIR 251 10.89 254 0.2+.1=.3 19 CONTROLLER/ 251 2.5 254 0.1+.3=.4 11 TIMER 20 THERMAL STORAGE 251 0.23 - 0.2+.5=.7 21 DESICCANT 251 0.23 - 0.2+.5=.7 22 CHECK VALVE 251 0.312 - 0.1+.2=.3 23 MANUAL VALVE 251 0.312 - 0.1+.2=.3 24 TEMPERATURE 251 7.183 - 0.1+.2=.3 25 RELIEF VALVE 251 7.183 - 0.1+.2=.3 26 RF GENERATOR (MAGNETON TUBE) 27 ACTUATOR 252 .024 0.2+.5=.7	4	ACCUMULATOR	100	0.01	•	0.5+.2=.7
7 TRANSMISSION 251 1.50 - 0.5+.1=.6 8 FLUIDIC SWITCH 251 1.61 - 1.0+.1=1.1 9 FILTER 251 0.16 - 0.1+.2=.3 10 ELECTRIC SWITCH 252 5.74 - 0.2+.1=.3 11 PRESSURE REGULATOR 100 2.94 254 0.1+.1=.2 REGULATOR 251 2.5 254 0.1+.3=.4 14 HIGH FREQUENCY - UNK - UNK 15 ELECTROACOUSTIC 252 86.2 254 0.1+.2=.3 16 HEAT EXCHANGER 251 0.23 254 0.2+.5=.7 17 HEATER-DC 251 1.0 - 0.2+.1=.3 18 BLOWER-AIR 251 10.89 254 0.2+.1=.3 19 CONTROLLER/ 251 2.5 254 0.1+.3=.4 119 CONTROLLER/ 251 0.23 - 0.2+.5=.7 17 HEATER-DC 251 1.0 - 0.2+.1=.3 19 CONTROLLER/ 251 0.23 - 0.2+.5=.7 17 HEATER-DC 251 1.0 - 0.2+.1=.3 19 CONTROLLER/ 251 0.23 - 0.2+.5=.7 20 THERMAL STORAGE 251 0.23 - 0.2+.5=.7 21 DESICCANT 251 0.23 - 0.2+.5=.7 22 CHECK VALVE 251 0.21 - 0.2+.5=.7 23 MANUAL VALVE 251 0.312 - 0.1+.2=.3 24 TEMPERATURE 251 7.183 - 0.1+.2=.3 25 RELIEF VALVE 251 0.312 - 0.1+.2=.3 26 RF GENERATOR (MAGNETON TUBE) 27 ACTUATOR 252 .024 0.2+.5=.7	5		251	1.77	#	0.5+.4=.9
S	6	WATER SEPARATOR	100	1.20	254	0.2+.2=.4
9 FILTER 251 0.16 - 0.1+.2=.3 10 ELECTRIC SWITCH 252 5.74 - 0.2+.1=.3 11 PRESSURE REGULATOR 100 2.94 254 0.1+.1=.2 12 VALVE (GN ₂) 100 0.72 254 0.1+.2=.3 13 CONTROLLER 251 2.5 254 0.1+.3=.4 14 HIGH FREQUENCY CONTROLLER 251 2.5 254 0.1+.2=.3 15 ELECTROACOUSTIC TRANSDUCER 251 0.23 254 0.2+.5=.7 17 HEATER-DC 251 1.0 - 0.2+.1=.3 18 BLOMER-AIR 251 10.89 254 0.2+.1=.3 19 CONTROLLER/ 251 2.5 254 0.1+.3=.4 11 TIMER 251 10.89 254 0.2+.1=.3 19 CONTROLLER/ 251 2.5 254 0.1+.3=.4 11 ERIMAL STORAGE 251 0.23 - 0.2+.5=.7 12 DESICCANT 251 0.23 - 0.2+.5=.7 13 CONTROLLER/ 251 0.23 - 0.2+.5=.7 14 EMERMAL STORAGE 251 0.23 - 0.2+.5=.7 15 ELECTROACOUSTIC 252 86.2 254 0.1+.2=.3 16 HEAT EXCHANGER 251 0.25 254 0.1+.2=.3 17 HEATER-DC 251 1.0 - 0.2+.5=.7 18 BLOMER-AIR 251 0.21 - 0.2+.5=.7 19 CONTROLLER/ 251 0.21 - 0.2+.5=.7 20 THERMAL STORAGE 251 0.21 - 0.2+.5=.7 21 DESICCANT 251 0.312 - 0.1+.2=.3 23 MANUAL VALVE 251 0.312 - 0.1+.2=.3 24 TEMPERATURE 251 7.183 - 0.1+.2=.3 25 RELIEF VALVE 251 0.312 - 0.1+.2=.3 26 RF GENERATOR (MAGNETON TUBE) 252 .024 0.2+.5=.7	7	TRANSMISSION	251	1.50		0.5+.1=.6
10	8	FLUIDIC SWITCH	251	1.61	-	1.0+.1=1.1
11	9	FILTER	251	0.16	-	0.1+.2=.3
REGULATOR VALVE (GN ₂) 100 0.72 254 0.1+.2=.3 13	10	ELECTRIC SWITCH	252	5.74	, Patairei Patairei	0.2+.1=.3
13	11		100	2.94	254	0.1+.1=.2
14	12	VALVE (GN ₂)	100	0.72	254	0.1+.2=.3
CONTROLLER ELECTROACOUSTIC TRANSDUCER 15 ELECTROACOUSTIC 252 86.2 254 0.1+.2=.3 16 HEAT EXCHANGER 251 0.23 254 0.2+.5=.7 17 HEATER-DC 251 1.0 - 0.2+.1=.3 18 BLOWER-AIR 251 10.89 254 0.2+.1=.3 19 CONTROLLER/ 251 2.5 254 0.1+.3=.4 1 1 1 1 1 1 1 1 1	13	CONTROLLER	251	2.5	254	0.1+.3=.4
TRANSDUCER 16 HEAT EXCHANGER 251 0.23 254 0.2+.5=.7 17 HEATER-DC 251 1.0 - 0.2+.1=.3 18 BLOWER-AIR 251 10.89 254 0.2+.1=.3 19 CONTROLLER/ 251 2.5 254 0.1+.3=.4 20 THERMAL STORAGE UNIT (WAX) 21 DESICCANT CANISTER 22 CHECK VALVE 251 0.21 - 0.2+.5=.7 24 TEMPERATURE CONTROL VALVE 251 0.776 - 0.1+.2=.3 24 TEMPERATURE CONTROL VALVE 251 7.183 - 0.1+.2=.3 25 RELIEF VALVE 251 0.312 - 0.1+.2=.3 26 RF GENERATOR (MAGNETON TUBE) 27 ACTUATOR 252 .024 0.2+.5=.7	14		.	ÚNK		UNK
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18 BLOWER-AIR 251 10.89 254 0.2+.1=.3 19 CONTROLLER/ TIMER 251 2.5 254 0.1+.3=.4 20 THERMAL STORAGE UNIT (WAX) 251 0.23 - 0.2+.5=.7 21 DESICCANT CANISTER 251 0.21 - 0.2+.5=.7 22 CHECK VALVE 251 0.312 - 0.1+.2=.3 23 MANUAL VALVE 251 0.776 - 0.1+.2=.3 24 TEMPERATURE CONTROL VALVE 251 7.183 - 0.1+.2=.3 25 RELIEF VALVE 251 0.312 - 0.1+.2=.3 26 RF GENERATOR (MAGNETON TUBE) UNK UNK UNK 27 ACTUATOR 252 .024 0.2+.5=.7	16	HEAT EXCHANGER	251	0.23	254	0.2+.5=.7
19	17	HEATER-DC	251	1.0		0.2+.1=.3
TIMER THERMAL STORAGE UNIT (WAX) 21 DESICCANT CANISTER 22 CHECK VALVE 251 0.312 - 0.1+.2=.3 23 MANUAL VALVE 251 0.776 - 0.1+.2=.3 24 TEMPERATURE CONTROL VALVE 251 7.183 - 0.1+.2=.3 CONTROL VALVE 251 0.312 - 0.1+.2=.3 UNK RELIEF VALVE 251 0.312 - 0.1+.2=.3 UNK UNK UNK UNK	18	BLOWER-AIR	251	10.89	254	0.2+.1=.3
UNIT (WAX) DESICCANT	19		251	2.5	254	0.1+.3=.4
CANISTER CHECK VALVE 251 0.312 0.1+.2=.3 0.1+.2=.3 10.776 TEMPERATURE CONTROL VALVE 251 7.183 0.1+.2=.3 0.1+.2=.3 0.1+.2=.3 0.1+.2=.3 UNK UNK UNK 10.1+.2=.3 0.1+.2=.3 0.1+.2=.3 0.1+.2=.3 0.1+.2=.3 0.1+.2=.3 0.1+.2=.3 0.1+.2=.3 0.1+.2=.3 0.1+.2=.3 0.1+.2=.3 UNK UNK	20		251	0.23		0.2+.5=.7
23	21		251	0.21		0.2+.5=.7
24 TEMPERATURE CONTROL VALVE 25 RELIEF VALVE 26 RF GENERATOR (MAGNETON TUBE) 27 ACTUATOR 25 TEMPERATURE 251 7.183 - 0.1+.2=.3 UNK UNK UNK 0.2+.5=.7	22	CHECK VALVE	251	0.312		0.1+.2=.3
CONTROL VALVE 25 RELIEF VALVE 26 RF GENERATOR UNK (MAGNETON TUBE) 27 ACTUATOR 251 0.312 - 0.1+.2=.3 UNK 0.2+.5=.7	23	MANUAL VALVE	251	0.776		0.1+.2=.3
26 . RF GENERATOR UNK UNK (MAGNETON TUBE) 27 ACTUATOR 252 .024 0.2+.5=.7	24		251	7.183		0.1+.2=.3
(MAGNETON TUBE) 27 ACTUATOR 252 .024 0.2+.5=.7	25	RELIEF VALVE	251	0.312		0.1+.2=.3
	26 .			UNK		UNK
28 PRESSURE SWITCH 251 3 57 - 0 1+ 2- 2	27	ACTUATOR	252	.024		0.2+.5=.7
1 20 1 111.22.3	28	PRESSURE SWITCH	251	3.57	20	0.1+.2=.3

R1_12

SECTION 2 TECHNICAL DATA

HABITABILITY SUBSYSTEM

1.0 Food Management

APPLIANCE FUNCTIONS CONSIDERED

1.1.1 Ambient Storage

1.1.2 Refrigerated Storage

1.1.3 Frozen Storage

1.2.2 Food Warming

1.3.1 Dishwasher/Dryer Combination

1.3.2 Dishwasher/Dryer w/Dishes

DESCRIPTION

The food management subsystem supplies all of the necessary functions for the storage and preparation of foods as well as the equipment required for the galley cleanup. Disposable dishes and utensils were considered as alternates to cleanup equipment. The three types of food storage were identified as ambient (dry or liquid), refrigerated, and frozen. The requirements for the food mix between these three categories are discussed later in this description.

Food preparation functions include rehydration of dry food and warming of frozen food. No considerations were made for the preparation of food mixes or cooking of food.

The cleanup equipment necessary to provide clean dishes and eating utensils for each crewmember for each meal was determined by first identifying the best mechanical cleaning systems and then comparing them against disposable dishes and utensils.

A large variety of spacecraft foods are available for crew consumption. These are typically divided into two major categories: wet (more than 5% moisture content) and dry (less than 5% moisture content). The dry food is considered to be shelf stable at ambient temperatures. The wet food is divided into three categories: (1) shelf stable at ambient temperature, (2) refrigerated, and (3) frozen. Obviously, a large variation in food mix could be chosen from these basic types. The Apollo wet/dry food mix was 20/80. For Skylab, it was 30/70. The crew requirement for drinking water from the potable water system will vary depending on the amount of water in the food mix. Also, the vehicle weight/volume/power penalty will depend on the type of food storage used--ambient, refrigerated, and frozen. To do a detailed optimization of the food system was beyond the scope of this study. Many of the decisions regarding food types depend on crew preference and psychological factors rather than strict weight/volume/power penalties. Consequently, it was decided to perform all the trades of food storage appliances based on the food mix used for Skylab. The weight and volume of frozen, refrigerated, and ambient storage food for Skylab is given in Table B2-1.

HABITABILITY SUBSYSTEM

1.0 Food Management (Continued)

TABLE B2-1

PLANNED SKYLAB FOOD WEIGHT AND VOLUME
(INCLUDING PACKAGING AND RESTRAINT) FOR 420 MAN-DAYS

	Total	Food Size		Food Size Per Unit	
Food Type	Weight kg (1b)	Volume cum (cu ft)	Number of Units	Weight kg (1b)	Volume cum (cu ft)
Frozen	121 (266)	0.299 (10.56)	5	24.1 (53.2)	0.0598 (2.11)
Refrigerated	24.1 (53.2)	0.0598 (2.11)	1	24.1 (53.2)	0.0598 (2.11)
Ambient Storage	955. (2106.)	2.60 (91.7)]1	87 (192.)	0.236 (8.34)

These are the initial launch values for a planned 420 man-days. These values were multiplied by 82/420 to adjust for the 82 man-days for Shuttle assumed in this study. (Note that no contingency is accounted for in this ratio since the Skylab food weights already include the actual contingency used for the Skylab mission.) The resulting size required for Shuttle food storage is shown in Table B2-2.

TABLE B2-2

REQUIRED SHUTTLE FOOD WEIGHT AND VOLUME
(INCLUDING PACKAGING AND RESTRAINT) FOR 82 MAN-DAYS

	of the second second					
	Total Food Size			Actual	Assumed Food Size	
Food Type	Weight kg (1b)	Volume cu m (cu ft)	Number of Shuttle Units Required	Number of Units Assumed	Weight kg (1b)	Volume cu m (cu ft)
Frozen	23.6 (52.0)	0.0583 (2.06)	0.976	1	23.6 (52.0)	0.0583 (2.06)
Refrigerated	4.72 (10.4)	0.0116 (0.41)	0.195	1	4.72 (10.4)	0.0116 (0.41)
Ambient Storage	186. (411.)	0.507 (17.9)	2.15	2	93.2 (205.5)	0.253 (8.95)

HABITABILITY SUBSYSTEM

1.0 Food Management (Continued)

A number of different refrigeration systems were found discussed in the literature reviewed, including dry ice, water sublimation, cryogenic storage, precooled heat sink, vapor compression, space radiator, thermoelectric, and air-cycle turbine/compressor. These concepts were all reviewed for missions of 84 to 2250 man-days, and only two (space radiator and thermoelectric) were found to be practical for space missions. Consequently, only the space radiator and thermoelectric concepts were examined in this study; and also, the air-cycle turbine/compressor was included for comparison since it represents a typical commercial aircraft system. Other types of refrigeration systems are available, such as Stirling and Brayton cycles. However, no information was found on application of these to spacecraft food chillers, so they were not included in the study.

HABITABILITY SUBSYSTEM	1.0 Food Manag	ement	
HABITABILITY FUNCTION_	1.1 Food Stora	ge	
APPLIANCE FUNCTION 1.	1.1 Ambient Food	Storage	
NUMBER OF CONCEPTS CONSID	DERED 2		
ASSUMPTIONS		•	
The ambient food storage (food management description		n this study wa	s as follows (see
Number of units			2
Individual unit p	ackaged food weigh	it 93.2 kg	205.5 lbs
Individual unit p	ackaged food volum	ne 0.253 cu m	8.95 cu ft
Total packaged fo	od weight	186.4 kg	411. lbs
Total packaged fo	od volume	0.507 cu m	17.9 cu ft

	0. 1.1.1	•••• AMBIEN	T FOOD S	TORAGE	SHUTTLE					•			
CONCEPT NO.	USAGE TIME	CONSUNABLES	AND FLOW	REQUIR	EHENTS	THERMAL	REQUIS	ELEC PWR R	EGHTS W	T/VOL REQ		LOPHENT	RESUPPLY
	SES/DAY_1	♥} →KG/USE→	•	-6444	⇒DEG C=	-WA!15-	-74115-	PK PWR AV AC DC 	ACWI	-KG→ -CU	M- 140	L INDEX	WEIGHT -KG- (LDS7
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2	•000					(0.)	(0•)	•0	•0	+0	•60 1 0•30)	10	•0 (•01
<u> </u>						<u> </u>							
1 :	RIGID FLEXIBI							1 - CABIN AIR 2 - CABIN AIR 3 - OXYGEN 4 - COOLING WATER 6 - HATER 6 - HITROGEN 7 - NITROGEN	(LOST) (LOST) R (CIRCULA (LOST)	TED), LITER , KG/HR , KG/HR TED), KG/HR TED), KG/HR TED), KG/HR	L (LB/ L (LB/ L (LB/ L (LB/ L (LB/ L (LB/	(HR) — (HR) — (HR) — (HR) — (HR) — (HR) — (HR)	
				+				8 - FREON 9 - WATER	(CIRCULA	TED), KG/HR ED), KG/HR	(LB/ (LB/		
	A Service and a	OF HIGH					(1 (2 (3		(CIRCULA' (PROCESSI	TED), KG/HR ED), KG/HR (***) IN	(LB/		

APPLIANCE	p - 15 a p - 4 a magnitude specific personal magnitude of accessing management
CONCEPT NO.	.C. O. N. CE., P., T , N., A., H. E
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2 - 1	FLEXIBLE

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CONCEPT NUMBER

Ambient Food Storage (Shuttle) Concept Trade

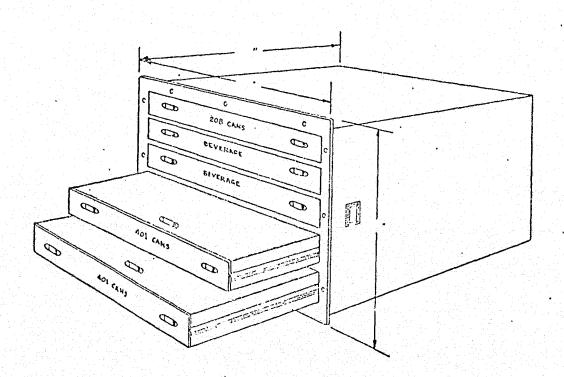
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SPACECRAFT_	<u>Shuttle</u>					
HABITABILIT	Y SUBSYSTEM Food M	anagement	_HABITABILITY	FUNCTION_	Food	Storage
APPLIANCE F	UNCTION Ambien	t Food Sto	rage			
APPLIANCE C	ONCEPT NO./TITLE	1/Rigid	Container			· · · · · · · · · · · · · · · · · · ·
INDEX NO	1.1.1.1		REF. NO.	177		

DESCRIPTION

In this concept, ambient food is contained in a rigid box-like container with shelves to retain the food. A structural weight of 26.3 kg per kg of food capacity was used from Reference 177. Volume was estimated on the basis of each individual storage locker being cubical in shape with 5.08 cm (2.0 inch) effective wall thickness on all sides.



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		WALL (BLOZEK)					
		WATE (DEOTAR)					
		WALL (DIO/AK)					
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source A/A	, Lee	<u>OPERAII</u> THERMAL AT LEAK	L TO COOLANT	ĘLECTRICAL	. WEIGH		VOLUME 3/MISSION
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source N/A	, Lee	<u>OPERAII</u> THERMAL AT LEAK	L TO COOLANT	ĘLECTRICAL	. WEIGH		
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SOURCE A//A	, Lee	<u>OPERAII</u> THERMAL AT LEAK	L TO COOLANT	ĘLECTRICAL	. WEIGH		
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SOURCE A/A	HE (BTU/I	<u>OPERAII</u> THERMAL AT LEAK	L TO COOLANT	ĘLECTRICAL	. WEIGH		
SOURCE A/A	HE (BTU/)	OPERATIC  THERMAI  AT LEAK IR/CYCLE) (1	L TO COOLANT	ĘLECTRICAL	. WEIGH	ion) (F	

CONCEPT <u>1</u>		pliance concept regi ontainer	JIPEMENTS AÑO	PLNALTILS CAL	CULATIONS (CONC	LUDED)	R 1.1.1.1
COMPONENT Totals	torage med	(REF)	<u> </u>	ME REG	LUIREMEN /	<u>r s</u>	volume (f1 ³ ) 27.9
		TOTAL	7.0	8 (15. KG (LBS) ,	6)	0.7	90 (27.9) M ³ (FT ³ )
TYPE	<u>S O L J</u> UNITS/		ABLE ② UNIT (REF) WT/UNIT)(REF) (LB)	3	R E Q U I R E M .E VOL/L (PKG. VC	LENIS (A)  (INIT)  (REF)  OL/UNIT)  (REF)	VOL/CYCLE  (FT3)
			Σα	TOTAL WI/O	CYCLE	Σ⑤	TOTAL VOL/CYCLE
TOTAL WT.	CYCLES/DAY	XDAYS/MIS	SION X	TOT.WI/CYCLE (LB)			KG (LB)
TOTAL VOL = MISSION =	CYCLES/DAY	X X	X	TOT.VOL/CYCI (FT³)	<b>.</b>		M³ (FT³)
	GAS	S/L I Q U I D E  AMT.USED/CYCLE(R (LB)	XPENDA	BLES R  ©  RECOVERY  FACTOR	EQUIREM!  AMT.RECOVER  DXG  (LB)	D/CYCLE	(1) AMT LOST/CYCLE (1) - (3) (LB)
	ΣΦ					Σ @	

#### D2-118561-2 `

SPACECRAFT	Shuttle			•	
HABITABILITY	Food SUBSYSTEM Mana		_ _HABITABILITY	FUNCTION	Food Storage
APPLIANCE FU	KCTION Ambien	t Food Stora	age		
APPLIANCE CO	CEPT NO. /TITLE_	2/Flexib	le Container		
INDEX NO	1.1.1.2		REF. NO	177	

#### DESCRIPTION

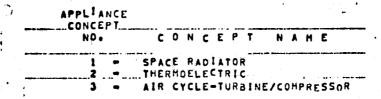
In this concept, an elastic netting material is used to retain the ambient food within retractable guides. Structural weight is assumed, according to Reference 177, to be 10 percent of the weight for the rigid concept. Volume was estimated on the basis of each individual storage locker being cubical in shape with 1.27 cm (0.5 inch) effective wall thickness on all sides.

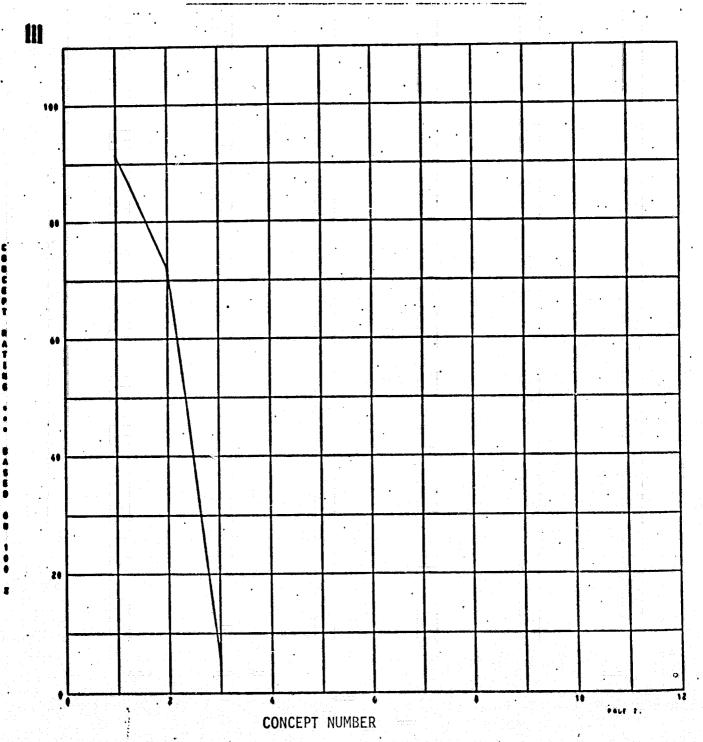
APPLIANCE CONCEPT REQUIREPENTS AND PENALTIES CALCULATIONS CONCEPT 2 / Flexible container THOLK HUMBER 1. J. 1. 2. REQUIREMENTS ELECTRICAL POHER POWER POWER (4) DEMARD DEMAND USE TIME ② (3) (5) **(6)** (WATT-HR/ CYCLE) (WATT-HR/ PEAK PEAK AVERAGE CYCLE AVERAGE CYCLE) COMPONENT ① x (1) · (REF) (HR) (WATTS) (NATTS) (WATTS) (WATTS) MUMIXAM TOTAL MUMIXAM TOTAL IHERMAL REQUIREMENTS HEAT LEAK TO COOLANT LATERT SENSIBLE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) SOURCE TOTAL WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) <u>OPERATIONAL</u> PENALTIES. THERMAL TO COOLANT WEIGHT VOLUME ELECTRICAL HEAT LEAK (FT3/MISSION) SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) TOTAL (FB/MI2210H) WAT1S/CYCLE/ (BTU/HR/CYCLE) (HT3/MISSION) WATTS/CYCLE (BTU/HR/CYCLE)

	•	•	REMENIS	
PONENT Fal storinge me	dule - empty	WEIGHT (LBS) 1.6		VOLUME (FT ³ )
101 Stot (198: The	(177)		_ /	20.3
			- <u> </u>	
**************************************				
	TOTAL	0.726 (1.6) KG (LBS) ,	0.5	57 <u>5 (20.3)</u> M³ (FT³)
<u>s</u>	<u>OLID EXPEND</u>	ABLE WI/VOL REQ	<u>UIREMENTS</u>	
TYPE U:	(PKG.W	②   WT/CYCLE     W	VOL/UNIT (REF (PKG. VOL/UNIT)( (FT3)	(5) VOL/CYCLE REF) (1) X (4) (FT ³ )
<u> </u>				
		750		
		TOTAL WT/CYCLE (LB)	- <b>2.</b>	TOTAL VOL/CYCLE
CYCLES/C	X DAYS/MISS	TOT. WI/CYCLE		KG (LB)
L VOL =		(L8)		
CYCLES/C	DAY DAYS/HISS	TOT. VOL/CYCLE (FT3)	<u> </u>	N ₁ (FT ₃ )
			IREMENIS  3	<b>(</b>
TYPE	<b>①</b> AMT.USED/CYCLE(RE (LB)	F) RECOVERY AMI	T.RECOVERED/CYCLE  ① X ② (LB)	(1)  AMT LOST/CYCLE (1) - (3) (LB)
TYPE	ANT. USED/CYTLE (RE	FACTOR	(LB)	(L3)

HABITABILITY SUBSYSTEM 1.0 Food Managemen	nt	·
HABITABILITY FUNCTION 1.1 Storage	•	
This I have a second and a second a second and a second a		<del></del>
APPLIANCE FUNCTION 1.1.2 Refrigerated S	torage	
NUMBER OF CONCEPTS CONSIDERED 3		
ASSUMPTIONS		
The Shuttle refrigeration capacity assumed in (see food management description):	this study was a	s follows
Number of units		1
Individual unit packaged food weight	4.71 kg (	10.4 lbs)
Individual unit packaged food volume	0.0116 cu m (	).41 cu ft)
Total packaged food weight	<b>4.71</b> kg (	10.4 1bs)
Total packaged food volume	0.0116 cu m (	0.41 cu ft)
Refrigerator box insulation thickness was as	sumed to be 10.16	cm (4.0 in)

Lagut	LNO.lalala		REFRIG	ERATED_I	000 510	RAGE_LSHL	LTTLE)		<u> </u>			<del> </del>			<del></del>	
CONCEP NO.	T. USAGE	C DNS	UMABLES_	AND FLOI	LREQUIRI	HENIS	THERMA	L_REGHTS_	ELEC P	WR REGHT	5#T/YOL_	REQUIS	PEVELOP COS		RESU	PPLY
••••	USES/DAY HRS/USE	(0) -	KG/USE-	•	+HHHG+	-DEG C-	-AATTS-	HT LEAK -WATTS+ -{BTU/HR}	DC	DC	WEIGHT	oCU M-	AYAIL I	NDEX_	TEI	
	.000		.0000.	•00	( .0)	( 40.0)	7. ( 30·)		50.Q_ •0		8,7 ( 17.6)	+04	1	0	•	.0,
<b>.2</b>	•000 •000						68. _(233.)	14.	100.0		14.1	•10		25	1	•0
	.000	,		. I				1060.			72.6			70	ſ	•0)
								1 2 2 2								
APPLIA CONCE					<u> </u>				<del></del>	<del></del>			·			
NO.		HCE	PT N	N E					(*) 1 - CABI	N AIR	(CIRCULATED	)	JSEC (FT	3 _{/Min} s		
	THERM			PRESSOR					2 - CABI 3 - OXYG	N AIR SEN LING WATER ER ROGEN ROGEN ON	(LOST) (LOST)	KG/HR KG/HR ), KG/HR KG/HR ), KG/HR KG/HR	(LB, (LB, (LB, (LB, (LB, (LB,	/HR) /HR) /HR) /HR) /HR) /HR) /HR) /HR)		
				OF POOR QUALITY					(1) AVAILA	OF THE AR	T REQUIRED	0 25 50	0ST 1CATOR -25% -50% -75% -100%			





Refrigerated Food Storage (Shuttle) Concept Trade

APPLIANCE FUNCTION: 1.1.2-REFRIGERATORS

				NU	I M B	E R	0	F	<b>C</b> 0	MPC	NE	N T S	)····				•
COMPONENT TYPE			SOLENOID	NGER	OLLER	<b>.</b> .											NUMBER OF SAFETY
APPLIANCE TYPE NO.	⊕ MOTOR	dwnd ②	SOLEN	⊕ HEAT EXCH/	© CONTROLLER	® BLOWER	0	0	$\circ$			O	0	0	$\circ$	0	CRITICAL ITEMS
SPACE RADIATOR	1	1	2	2	.1	-		Ų.							<u> </u>		0
THERMOELECTRIC	2	-	_	-	1	2											1
AIR CYCLE TURBINE/COMPRESSOR	2	2		1	1	1											. 0
					·	-											
	ir dá Gailte a s											•					. •
																	-
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SPACECRAFT_	Shuttle		<del>-</del>			
HABITABILIT	Y SUBSYSTEM Food	Management	_HABITABILIT	Y FUNCTION_	ood Storage	!
APPLIANCE F	UNCTION Refrige	erated Storag	e			
APPLIANCE C	ONCEPT NO./TITLE	1/Space Ra	diator	. knimi		
INDEX NO	1.1.2.1		_REF. NO	184, 255	and the	:

### **DESCRIPTION**

This concept is simply an insulated food storage box, with coolant from the spacecraft ECS radiators routed through tubing within the refrigerator walls. This concept was used for the Skylab refrigerator, which had the following size:

•	1 2 2		WEI	GHT	VOLUME		
			kg	1b	cu m	cu ft	
Food capacity	(packaged and	restrained)	24.1	53.2	0.0598	2.11	
Total refrige	erator (empty)		45.8	101	0.210	7.41	

The Shuttle refrigerator was sized proportional to the above Skylab data based on the refrigerator food capacity. The wall insulation was 10.16 cm (4.0 in) thick. It was assumed that the radiator coolant would be of sufficiently low temperature for this concept to be feasible.

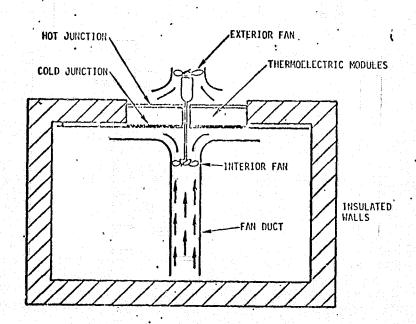
ONCEPT Space radiat	<u>or retri</u>	ice concept require	LIENTS MIU	FUNCTIES CALL	INDEX NUM	BER 1.1.2.1
(Ref # 184 p4.1	-4.5)					
	ELLC.		<u>D N E R</u>	REQUIRE		POWER
OMPONENT (REF)	USE TIME CYCLE (HR)	A C  PEAK (WATTS)	POWE  3  AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) (1) X (3)		(MATT-H VERAGE (VCLE) WATTS) (VX (7)
Controls, values, sensors, illumi- zation		50				
		***************************************				
				TOTAL	MAXIMUM	TOTAL
	•					
		IHERMAL	REQUI	REMENTS		
SOURCE		LATENT (BTU/HR)		SIBLE U/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Box heat leak		<u>o</u> ·		0	<u> </u>	30
Electrical	•	0		71	171	0
	<b>TOTAL</b>	0		(171)	(141)	(30
RIGINAL PAGE'IS		WATT (BTU/HR)	WATT	(BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)
F POOR QUALITY						
		<u>OPERATION</u>	AL PE	NALIIE	<u>s</u>	
\$OURCE.		THERMAL T LEAK TO L/CYCLE) (BTU/	COOLANT HR/CYCLE)	ELECTRICA (PK WATTS/C		VOLUME ) (FT ³ /MISSION
			•			
70	TAL NAT	TS/CYCLE WAT	TS/CYCLE		KG/NISSION	M3/M1S510N

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

INDEX NUMBER 1. 1.2.1 CONCEPT Space vadiator refrigerator WEIGHI/YOLUME REQUIREMENTS VOLUME (FT³) 1.44 WEIGHT (LBS) COMPONENT (REF) 19.6 ORIGINAL PAGE IS (1.44 TOTAL (19.6)OF POOR QUALITY M3 (FT3) -KG (LBS) EXPENDABLE W T/V O L REQUIREMENTS SOLID VOL/UNIT (REF)
(PKG.VOL/UNIT)(REF)
(FT3) ②
WT/UNIT (REF)
(PKG.WT/UNIT)(REF)
(LB) UNITS/CYCLE(REF) TYPE  $\overline{\Sigma}$   ${}_{ar{5}}$  $\overline{\Sigma}$ TOTAL VOL/CYCLE TOTAL WT/CYCLE (LB) TOTAL WT. TOT.WT/CYCLE (LB) KG (LB) CYCLES/DAY DAYS/MISSION TOTAL VOL . M3 (FT3) CYCLES/DAY DAYS/MISSION REQUIREMENIS EXPENDABLES TOST/CACTE 0 AMT.RECOVERED/CYCLE 1 RECOVERY AMT.USED/CYCLE(REF) TYPE FACTOR  $\Sigma$  ①  $\Sigma$  ① TOTAL LOST/CYCLE (# 4) DAYS/MISSION KG (LB) CYCLE/DAY (LB) (z (1)

SPACECRAFT	「 <u>Shuttle</u>	- And the second		• .
HABITABIL	ITY SUBSYSTEM Food Man	agement HABITABILIT	Y FUNCTION_	Food Storage
APPLIANCE	FUNCTION Refrigerat	ed Stòrage		
APPLIANCE	CONCEPT NO./TITLE 2	/Thermoelectric	• • • • • • • • • • • • • • • • • • • •	
INDEX NO.	1.1.3.2	REF. NO	184, 177	

DESCRIPTION: In this concept, the refrigerator has a self-contained cooling unit operating on the thermoelectric principle. Direct electrical current is passed through staged semi-conductor junctions arranged such that heat is removed at one set of junctions (providing the cooling) and rejected at the other. The freezer engineering data used were taken from Reference 184 and 177, which were obtained from catalogue data for commercial units. The reference weight and volume were given separately for the freezer locker and the thermoelectric devices. To keep the concepts on a common basis, the weight and volume of the locker were assumed equal to the locker for the space radiator concept #1.

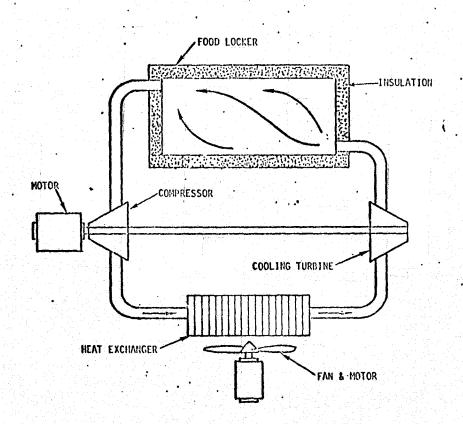


THERMAL REQUIREMENTS  AC. POWER  AC. POWER  DC. POWER  OCYCLE  PRAK AVERAGE  CONFORMAT  (REF) (UR) (WATTS) (WATTS)  DV. PEAK AVERAGE  CONFORMAT  (REF) (UR) (WATTS) (WATTS)  DV. PEAK AVERAGE  CONFORMAT  (WATTS) (WATTS) (WATTS)  DV. PEAK AVERAGE  CONFORMATION  THERMAL REQUIREMENTS  INCLUDED  NAXIMUM  TOTAL  INCLUDED  NAXIMUM  TOTAL  INCLUDED  NAXIMUM  TOTAL  INCLUDED  NAXIMUM  TOTAL  INCLUDED  SOURCE  (STUJAR)  CONFORMATION  TOTAL  OCCUPANT  OCCUPANT  TOTAL  OCCUPANT  OCCUPANT  TOTAL  OCCUPANT  OCCUPANT  TOTAL  OCCUPANT  OCCUP	concept Thermeelectr (Ref. # 184 p 4.				- 1		
SOURCE LATER SEQUIREMENT (BET) (BATTS)  THE R HAL REQUIREMENT (BATTS)  TOTAL DOG COLOR (BUT)  NAXIBUM TOTAL HEAT LEAK TO COOLANT (BTU/HR)  TOTAL DOG COLOR (BTU/HR)  SOURCE (BTU/HR)  TOTAL DO COLOR (BTU/HR)  TOTAL DOG COLOR (BTU/HR)  SOURCE (BTU/HR)  TOTAL DOG COLOR (BTU/HR)  SOURCE (BTU/HR)  TOTAL DOG COLOR (BTU/HR)  TOTAL DOG COLOR (BTU/HR)  SOURCE (BTU/HR)  TOTAL DOG COLOR (BTU/HR)  TOTAL DOG COLOR (BTU/HR)  SOURCE (BTU/HR)  SOURCE (BTU/HR)  TOTAL DOG COLOR (BTU/HR)  SOURCE (BTU/HR)  SOURCE (BTU/HR)  SOURCE (BTU/HR)  TOTAL DOG COLOR (BTU/HR)  SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (BTU/HR/CYCLE) (LEAM)SSION)  TOTAL COLOR ELECTRICAL METGET VOLUME  SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK MATTS/CYCLE) (LEAM)SSION)  TOTAL COLOR THERMAL COLOR (BTU/HR/CYCLE) (BTU/HR/	Citati tai I	ELECI	RICAL	POWER	REQUIRE	MENTS	
CYCLE PEAR AVERAGE CATTURE PEAR AVERAGE PEAR A		<b>0</b>	<u> </u>	C.POWE	R	D C	POWER
THERMAL SENSIBLE HEAT LEAK TO COOLANT SOURCE (BTU/HR) MATT (BTU/HR)  TOTAL  O					DEMAND (WATT-HR/		(6) DEMAND
Thermee lectric elevices, fans, illumination.  IHERMAL REQUIREMENTS  SOURCE (STU/HR) (STU/HR) (STU/HR) (STU/HR)  TOTAL D (231) (42) (233)  MATT (STU/HR) MATT (STU/HR) MATT (STU/HR)  POPERATIONAL PENALTIES  WATT (STU/HR) MATT (STU/HR) MATT (STU/HR)  OPERATIONAL PENALTIES  WATT (STU/HR) SOURCE (STU/HR/CYCLE) (PK MATTS/CYCLE) (LB/MISSION)	COMPONENT (PEF)				CYCLE)		(AEKYOR CACLE)
TOTAL  Deep light of the power		(185)	(40112)	(40113)	Ó٠		sani (s)
THERMAL BEQUIREMENTS  IHERMAL BEQUIREMENTS  LATENT SENSIBLE HEAT LEAK (BTU/HR) (BTU/HR) (BTU/HR)  Box head leak O -30 -30 O  Electrical power O 3/1/ 78 233  TOTAL O (281) (48) (253)  NATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) HATT (BTU/HR)  OPERATIONAL PENALTIES  HEAT LEAK THERMAL TO COOLANT COLOLANT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  SOURCE. (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/HISSION) (FT/MISSION)							
THERMAL BEQUIREMENTS  SOURCE LATENT SENSIBLE HEAT LEAK TO COOLANT (BTU/HR) (BTU/HR) (BTU/HR)  BOX Load leak O -30 -30 O  Electrical power O 311 7.8 233  TOTAL O (281) (48) (233)  NATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  OPERALLOMAL PENALTIES  HEAT LEAK TO COOLANT ELECTRICAL METGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK MATTS/CYCLE) (LB/MISSION) (FT ² /MISSION)							
THERMAL BEQUIREMENTS  SOURCE LATENT SENSIBLE HEAT LEAK TO COOLANT (BTU/HR) (BTU/HR) (BTU/HR)  BOX Load leak O -30 -30 O  Electrical power O 311 7.8 233  TOTAL O (281) (48) (233)  NATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  OPERALLOMAL PENALTIES  HEAT LEAK TO COOLANT ELECTRICAL METGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK MATTS/CYCLE) (LB/MISSION) (FT ² /MISSION)	· · · · · · · · · · · · · · · · · · ·				-+		
THERMAL BEQUIREMENTS  SOURCE LATENT SENSIBLE HEAT LEAK TO COOLANT (BTU/HR) (BTU/HR) (BTU/HR)  BOX Load leak O -30 -30 O  Electrical power O 311 7.8 233  TOTAL O (281) (48) (233)  NATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  OPERALLOMAL PENALTIES  HEAT LEAK TO COOLANT ELECTRICAL METGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK MATTS/CYCLE) (LB/MISSION) (FT ² /MISSION)		<del></del>					
I HERMAL REQUIREMENTS  LATENT SENSIBLE HEAT LEAK TO COOLANT SOURCE (BTU/HR) (BTU/HR) (BTU/HR)  Box heat leak O -30 -30 O  Electrical power O 311 78 233  TOTAL O (281) (47) (233)  MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  OPERATION AL PENALTIES  THERMAL TO COOLANT ELECTRICAL METONT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK MATTS/CYCLE) (LB/MISSION) (FT3/MISSION)							
I HERMAL REQUIREMENTS  LATENT SENSIBLE HEAT LEAK TO COOLANT SOURCE (BTU/HR) (BTU/HR) (BTU/HR)  Box heat leak O -30 -30 O  Electrical power O 311 78 233  TOTAL O (281) (47) (233)  MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  OPERATION AL PENALTIES  THERMAL TO COOLANT ELECTRICAL METONT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK MATTS/CYCLE) (LB/MISSION) (FT3/MISSION)		··				<del></del>	
I HERMAL REQUIREMENTS  LATENT SENSIBLE HEAT LEAK TO COOLANT SOURCE (BTU/HR) (BTU/HR) (BTU/HR)  Box heat leak O -30 -30 O  Electrical power O 311 78 233  TOTAL O (281) (47) (233)  MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  OPERATION AL PENALTIES  THERMAL TO COOLANT ELECTRICAL METONT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK MATTS/CYCLE) (LB/MISSION) (FT3/MISSION)					•	100	
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SOURCE (BTU/HR) SENSIBLE HEAT LEAK TO COOLAINT BOX heat leak 0 -30 -30 O  Electrical power 0 311 78 233  TOTAL 0 (281) (48) (233)  MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  OPERATIONAL PENALTIES  HEAT LEAK THERMAL TO COOLAINT ELECTRICAL WEIGHT (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT3/MISSION)  TOTAL					•		
SOURCE (BTU/HR) SENSIBLE HEAT LEAK TO COOLAINT BOX heat leak 0 -30 -30 O  Electrical power 0 311 78 233  TOTAL 0 (281) (48) (233)  MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  OPERATIONAL PENALTIES  HEAT LEAK THERMAL TO COOLAINT ELECTRICAL WEIGHT (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT3/MISSION)  TOTAL		•					
SOURCE (BTU/HR) SENSIBLE HEAT LEAK TO COOLAINT BOX heat leak 0 -30 -30 O  Electrical power 0 311 78 233  TOTAL 0 (281) (48) (233)  MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  OPERATIONAL PENALTIES  WHEAT LEAK (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT3/MISSION)  TOTAL  TOTAL							
SOURCE (BTU/HR) SENSIBLE HEAT LEAK TO COOLAINT BOX heat leak 0 -30 -30 O  Electrical power 0 311 78 233  TOTAL 0 (281) (48) (233)  MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  OPERATIONAL PENALTIES  WHEAT LEAK (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT3/MISSION)  TOTAL  TOTAL		•	Chermai	REOUTI	FMFNTS		
SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR)  Box heat leak 0 -30 -30 O  E/estrical power 0 311 78 233  TOTAL O (281) (48) (233)  NATT (BTU/HR) NATT (BTU/HR) NATT (BTU/HR)  OPERATIONAL PENALTIES  HEAT LEAK TO COOLANT ELECTRICAL NEIGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK NATTS/CYCLE) (LB/MISSION) (FT3/MISSION)			THENHUE	REARTI			
Box heaf leak 0 -30 -30 O  Electrical power 0 311 78 233  TOTAL 0 (281) (48) (233)  MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  OPERAILONAL PENALTIES  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISSION)	•						
TOTAL  O (281)  OPERAIION AL PENALIIES  THERMAL  JURAT LEAK TO COOLANT (BTU/HR/CYCLE)  (BTU/HR/CYCLE)  TOTAL  OPERAIION AL PENALIIES  THERMAL  JURAT LEAK  TO COOLANT (BTU/HR/CYCLE)  (BTU/HR/CYCLE)  (BTU/HR/CYCLE)  TOTAL	SOURCE		(BTU/HR)	(BTI	I/HR)	(BTU/HR)	(BTU/HR)
TOTAL  O  (231)  O  (48)  (233)  NATT (BTU/HR)  NATT (BTU/HR)  D P E R A I I O N A L  FIERMAL  HEAT LEAK  TO COOLANT  (BTU/HR/CYCLE)  (BTU/HR/CYCLE)  (BTU/HR/CYCLE)  TOTAL  TOTAL	Box heat leak		<u> </u>		30	30	
TOTAL  O  (281)  (48)  (233)  NATT (BTU/HR)  VOLUME  (BTU/HR/CYCLE)  (BTU/HR/CYCLE)  (BTU/HR/CYCLE)  TOTAL		•	0	3	11	78	233
TOTAL O (231) (48) (233)  NATT (BTU/HR) NATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  OPERATIONAL PENALTIES  THERMAL TO COOLANT ELECTRICAL WEIGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT3/MISSION)  TOTAL		•					
TOTAL O (231) (48) (233)  NATT (BTU/HR) NATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  OPERATIONAL PENALTIES  THERMAL TO COOLANT ELECTRICAL WEIGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT3/MISSION)  TOTAL							
TOTAL O (231) (48) (233)  NATT (BTU/HR) NATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  OPERATIONAL PENALTIES  THERMAL TO COOLANT ELECTRICAL WEIGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT3/MISSION)  TOTAL		•		•			
WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  OPERATIONAL PENALTIES  THERMAL TO COOLANT ELECTRICAL WEIGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISSION)  TOTAL		•					
DPERATIONAL PENALTIES  THERMAL TO COOLANT ELECTRICAL WEIGHT VOLUME  SOURCE. (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISSION)  TOTAL		TOTAL .					
THERMAL TO COOLANT ELECTRICAL WEIGHT VOLUME  SOURCE. (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISSION)  TOTAL			WATT (BTU/HR)	WATT	BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)
THERMAL HEAT LEAK TO COOLANT SOURCE.  (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION)  TOTAL			•			and the state of t	
THERMAL HEAT LEAK TO COOLANT SOURCE.  (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION)  TOTAL							
THERMAL HEAT LEAK TO COOLANT SOURCE.  (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION)  TOTAL						-	
THERMAL HEAT LEAK TO COOLANT SOURCE.  (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION)  TOTAL							
SOURCE. (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISSION)  TOTAL		<u>0</u>	PERAILO	NAL PE	NALTIES		
SOURCE. (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISSION)  TOTAL			THERMAL		ELECTOTOAL	VETCUT	VOLUME
TOTAL	SOURCE.						
TOTAL							
TOTAL		<del></del>	<del></del> '			· · · · · · · · · · · · · · · · · · ·	
TOTAL						•	
TOTAL WATE-COVELE WATE-COVELE WATE-COVELE							
TOTAL WATTS/COVELE WATTS/COVELE WATTS/COVELE							· · · · · · · · · · · · · · · · · · ·
TOTAL WATE-COVELE WATE-COVELE			· · · · · · · · · · · · · · · · · · ·		4 <u>1 </u>		
TOTAL WATE /CVCLE WATE /CVCLE							
MATERIAL MAT	T(	DTAL LIATT	S/CYCLE	ATTS/CYCLE		KG/MISSION	M³/MISSION

ONCEPT Thermpeles	APPLIANCE CONCEPT RE		NALTIES CALCULAT	IONS (CONCLUDED)  INDEX NUM	BER 1.1.2.2
omponent Thermoelectric Perrigerator locker	(REF)	GH T/V OLUMI	EIGHT (LBS) 4	REMENTS	VOLUME (FT ³ ) 2.0 1.44
			•		
	TOTAL			UIREMENIS	(3.4) N³ (FT³) ·
TYPE UNI	(PKG	DABLE WI (2) /UNIT (REF) .WT/UNIT)(REF) (LB)	MT/CYCLE ①X② (LB)	VOL/UNIT (REF) (PKG. VOL/UNIT) (REF) (FT3)	VOL/CYCLE (FT3)
		Σ3	TOTAL WT/CYCLE	Σ (	TOTAL VOL/CYCLE  (FT3)
OTAL WT.  OTAL VOL  MISSION = CYCLES/DA	<b>.</b>	<b>.</b>	OT.WT/CYCLE (LB)  OT.WOL/CYCLE (FT ³ )	•	KG (LB)
TYPE	A S/L 1 Q U 1 D  AMT. USED/CYCLE( , (LB)			I REMENIS  T.RECOVERED/CYCLE  OX(2) (LB)	AMT LOST/CYCLE  ①-③ (LB)
DITAL HT MISSION CYCLE/DAY	①XDAYS/MISSION	* 10TAL 1.05Y/CY(	au •	ΣΦ	KG (LB)

SPACECRAFT_	Shuttle			•	**			
HABITABILIT	Y SUBSYSTEM	Food I	Management	_HABITABILI	TY FUNC	TION	Food Stor	age
APPLIANCE F	UNCTION	Refr	igerated St	orage	•			
APPLIANCE: C	ONCEPT NO./	TITLE_	3/Air-c	ycle turbin	e/compr	essor	· .	
INDEX NO	1.1.2.3			REF. NO	184			

DESCRIPTION: In this concept, air is alternately compressed and expanded in a closed refrigeration cycle. This concept was included for comparison since it represents a typical commercial aircraft system. In an aircraft, ram air is used to cool the heated working fluid, whereas in the spacecraft system a motor and fan are used.



(Ref. # 184 pp 4	13-4.16, A.34	/ - A.46)	OWER	<u>R E Q U I R E</u>	MENTE		
	· ·	A C		•	D C	POWER	
COMPONENT (REF)	USE TIME  CYCLE  (HR)	PEAK (WATTS)	(3) AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) (1) X(3)	⑤ PEAK (WATTS)	6 DE (WAT CYC	MAND T-HR/ LE)
Compressor & fan	,	10,2.00					
		10 200					
		10,200 MAXIMUM		TOTAL	MAXIMUM	, 10	TAL
	<u>I H</u>	ERMAL	REQUI	REMENIS			
SOURCE		LATENT (BTU/HR)	SEN:	SIBLE J/HR)	HEAT LEAK (BTU/HR)	TO COOLAN (BTU/HR)	
Box heat leak		0 .		<u>30</u>	-30		مندجد
Electrical powe	r	0		724	3650	12.74	
	TOTAL	0 -		(4494)	(3620	) (12	<u>74)</u>
		TT (BTU/HR)	WATT (	BTU/HR)	WATT (BTU/HR)	WATT (BTU/	
	<u>0 P</u>	<u>E R A I I O N</u>	AL PE	NALTIE:			
SOURCE.	HEAT LE (STU/HR/CYC		COOLANT /HR/CYCLE)	ELECTRICAL (PK WATTS/C		VOLUME ON) (FT³/MISSI	(ио)
	OTAL NATTS/C	VCIF UA	TTS/CYCLE		KG/M1SS10	M3/M18810	

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS. (CONCLUDED)

					_	
	EIXED	ME'T. BHIND		UIREMENI	•	
COMPONENT -	(REF)		WEIGHT (LBS)		VOLUME (FT ³ )	
Refrigeratur	(total)	•	160	<u> </u>	4-2	
		•				
	*	•				<del></del>
						,
		-				
			•		<del></del>	<u> </u>
				<del></del>		
	TOTAL	· · · · · · · · · · · · · · · · · · ·	. (160		(/	1-2)
		<del>   </del>	' KG (LBS)	2_1 L	M3 (FT3)	-27
					•	
	SOLID EXI	ENDABLE	MINTOF I	REQUIREME	N I S	a.
	0	WT/UNIT (REF) (PKG. WT/UNIT)(R (LB)	Ø ₩T/CYCLI	E VOL/UNI (PKG.VOL/U (FT	A) ( T (REF) VOL/C	YCLE
TYPE	UNITS/CYCLE(REF)	(LB)	EF) ① X ② (LB)	(FT	JNIT)(REF) ①X (FT	3)
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¥			<del></del>			•
-		•				<del></del>
	e de la companya del companya de la companya de la companya del companya de la companya del la companya de la c					
		Σ	TOTAL WI/C	VCI F	Σ ⑤ TOTAL VO	/cvc) s
ATA: 17			(LB)	1022	(FT	3)
OTAL WT.	LES/DAY DA	X YS/MISSION X	TOT LET (CVC) E		KG (LB)	
	LLS/UNI UF	(13/11/33/011	TOT.WT/CYCLE (LB)		KG (LD)	
MISSION =	x	<u> x</u>				
CYC	LES/DAY DA	YS/MISSION	TOT. VOL/CYCLE (FT3)	<b>.</b> 	M3 (FT3)	
				•		
	<u>6 A S/L I Q U I I</u>	EXPEND	ABLES RI	<u>EQUIREMEN</u>	<u>I S</u>	
		<b>D</b>	<b>②</b>	AMT RECOVERED/	CYCLE AMT LOST	) /CYCLE
TYPE	AMT.USED/C	YCLE(REF)	RECOVERY FACTOR	AMT.RECOVERED/O ① X ② (LB)	CYCLE AMT LOST ①-( (LB	3
				•	No.	<u> </u>
						<del>-,,</del> -
		•			+	
	70	<del></del>			Σ⊚	
	Σ ①				40	
OTAL WT.						

HABITABILITY SUBSYSTEM	1.0	Food Management	
HABITABILITY FUNCTION_	1.1	Storage	
APPLIANCE FUNCTION	1.1.3	Frozen Storage	
NUMBER OF CONCEPTS CONS	SIDERED	3	

# **ASSUMPTIONS**

The Shuttle freezer capacity assumed in this study was as follows (see food management description):

Number of Units		. : <b>1</b>		
Individual unit packaged food weight	23.6 kg	<b>52.</b> 1bs		
Individual unit packaged food volume	.058 cu m	2.06 cu ft		
Total packaged food weight	23.6 kg	52. 1bs		
Total packaged food volume -	.058 cu m	2.06 cu ft		

B2-32

APPLIANCE

ONCEPT CONCEPT NO. SPACE RADIATOR
THERMOELECTRIC
AIR CYCLE-TURBINE/COMPRESSOR 100 20 .... CONCEPT NUMBER

Frozen Food Storage (Shuttle) Concept Trade

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•							•		<i>;</i> 
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-, -	USES HOD		O IRECT TO C	OOLANT	(LB/BT	UH) •0:	250		*
<u>-</u>	THERMAL P	ENALTY - C	ABIN HEAT	LEAK	(LB/BT				
-, :			WATT) TYPE						
			en e						
				***					
		SELECTION	HATRIX .	• •	•. •	FRCZEN I	FOOD ST	TORAGE (SHUTTLE)	
ے ک				12/15/	7.4 )				
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J		MIN	XAM		-			CONCEPT	
0	FACTOR	VALUE	VALUE	PTS	1	. 2	3		
	WEIGHT	98.700	723.00		12.95		•00		
0 -	POWER VOLUME	7.2500	8056.0 135.00	10	9 • 4 6	8.98	•00		
1 (1) <del>4</del>	THERMAL RELIABTY		488.05 •99304	15	14.88 2.85	13.53_ -20	- 00 ·		<del></del>
O _	MAINTENC	_ •99998	99999 _	S-	2.65		•00 -		
	SAFETY DEV COST-	.00000 00000	1.0000 70.000	15-	5.00 15.00	•00 9•64	5.09 		
၁ <u> </u>	TOTAL PT	•00000	85.000	85	77.75	58.25	5.00		
0 -	RATING	•00000	100+00	100	91.48	68.53	5.88		
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APPLIANCE FUNCTION: 1.1.3-FREEZERS

	<del>,</del>		· · · · · · · · · · · · · · · · · · ·														
		,		ΝŲ	МВ	E R	0	F	C O	мРО	NE	N T S	3		4		
COMPONENT TYPE  APPLIANCE TYPE  NO.	(1) МОТОЯ	MNH@	© SOL ENOID VALVE	HEAT EXCHANGER	S CONTROLLER	® BLOWER	0	0	0	C		0	0	0	0	0	NUMBER OF SAFETY CRITICAL ITEMS
SPACE RADIATOR	1	1	2	2	1	-		<u> </u>							<u> </u>		0
THERMOELECTRIC	2	-	-	-	1	2											1
AIR CYCLE TURBINE/COMPRESSOR	2	2		1	1	1											0
																	·
										•				•			
										•				•			•
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B2-36

SPACECRAF"	T <u>Shuttle</u> .		• •	•,	• •	•		
HABITABIL	ITY SUBSYSTEM Food	Management	HABITABILI	TY FU	NCTION	Food	Storage	
<b>APPLIANCE</b>	FUNCTION Frozen	Storage			· · · · · · · · · · · · · · · · · · ·			
APPLIANCE	CONCEPT NO./TITLE_	1/Space	Radiator					<del></del>
INDEX NO.	i.1.3.1		REF. NO	184	, 255		·	

## DESCRIPTION

This concept is simply an insulated food storage box, with coolant from the spacecraft ECS radiators routed through tubing within the freezer walls. This concept was used for the five Skylab food freezers, each of which had the following size:

	· WEIG	SHT	VOLU	ME
	kg	ÌЬ	_m 3	ft ³
Food capacity (packaged and restrained)	24.1	53.2	0.0598	2.11
Total freezer (empty)	45.8	101	0.210	7.41

The Shuttle freezer was sized proportional to the above Skylab data based on the freezer food capacity. The wall insulation was 10.16 cm (4.0 in) thick. It was assumed that the radiator coolant would be of sufficiently low temperature for this concept to be feasible.

CONCEPT Space radial	APPLIANCE CONCEPT REQUIR	REMENTS AND F	ENALTIES CALCU	LATIONS INDEX NUM	BER 1.1.3.1
(Ref. # 184 p4	1.1-4.5)	e tuar Line	•	****	
	ELECTRICAL P		REQUIRE		
•	0	POWE		<u>9 C</u>	POWER  (5) DEMAN
	USE YIME ② CYCLE PEAK	③ AVERAGE	(4) DEMAND (WATT-HR/	⑤ PEAK A	WATT-H
OMPONENT (REF)	(HR) (WATTS)	(WATTS)	CYCLE)		WATTS) CYCLE)
Controls valves	50		00	, , ,	
Humination.				•	
ensors					
			· <del></del>	-	
	, a <u> </u>				
	50.				
and the second of the second o	MAXIMUM		TOTAL	MAXIMUM	TOTAL
		• .		•	,
			•		
				•	
	THERMAL'	REQUI	EMENTS		
	LATENT	SENS	IBLE	HEAT LEAK	TO COOLANT
SOURCE	(BTU/HR)	(BTI	I/HR)	(BTU/HR)	(BTU/HR)
Box heat leak	0		'n	-188	188
Electrical	0	17	·/	171	0
_760777001			<del>-1</del>		
			<del></del>	- <del></del>	er er er <u>dammadamannan da</u> Later er e
			•		And the second s
τ(	OTAL O		(171)	(-17)	(188
	WATT (BTU/HR)		BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)
		•			
		677			
	<u>O P E R A T I O N</u>	AL PE	NALTIES		
	THERMAL HEAT LEAK TO	COOLANT /HR/CYCLE)	ELECTRICAL	WEIGHT	VOLUME
SOURCE.	(BTU/HR/CYCLE) (BTU	/HR/CYCLE)	(PK WATTS/CYC	CLE) (LB/MISSION)	(FT ³ /MISSION)
			•		
				<del></del>	
		<del></del>			
				-	
					<u> </u>
<b>T01</b>	AL CONTRACTOR				
	WATTS/CYCLE WA	TIS/CYCLE		KG/MISSION	M3/MISSION

. .

TOTAL WT.

CYCLE/DAY

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED) radiator INDEX NUMBER 1.1.3 freezer FIXED WEIGHT/VOLUME REQUIREMENTS WEIGHT (LBS) VOLUME (FT3) COMPONENT (REF) 98.7 7.25 Freezer TOTAL KG (LBS) M3 (FT3) EXPENDABLE W T/V O L REQUIREMENTS SOLID (PKG.WT/UNIT)(REF) . ③ WT/CYCLE ①X② (LB) VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³) 0 UNITS/CYCLE(REF) TYPE  $\Sigma$   ${}_{ar{\mathbb{S}}}$  $\overline{\Sigma}$ TOTAL VOL/CYCLE TOTAL WT/CYCLE (LB) TOTAL WT. = TOT.WT/CYCLE (LB) CYCLES/DAY DAYS/MISSION KG (LB) TOTAL VOL = DAYS/MISSION TOT.VOL/CYCLE CYCLES/DAY M3 (FT3) (FT3) REQUIREMENTS G A S/L 1 Q U 1 D EXPENDABLES @ AMT.RECOVERED/CYCLE

① X ②

(LB) AMT LOST/CYCLE ① RECOVERY AMT. USED/CYCLE (REF) TYPE (LB) **FACTOR**  $\Sigma$  (4)  $\Sigma$  ① 1

TOTAL LOST/CYCLE (Z (2)

(LB)

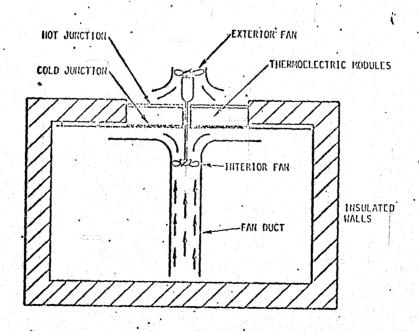
(z (1)

KG (LB)

DAYS/MISSION

SPACECRAFT	Shuttle				
HABITABILI	TY SUBSYSTEM Food	Management HA	BITABILITY	FUNCTION_	Food Storage
APPLIANCE	FUNCTION Frozen	Food Storage	•	· · · · · · · · · · · · · · · · · · ·	
APPLIANCE	CONCEPT NO./TITLE_	2/Thermoelec	tric		and the second s
INDEX NO	1.1.3.2	R	EF. NO.	184, 177	

DESCRIPTION: In this concept, the freezer has a self-contained cooling unit operating on the thermoelectric principle. Direct electrical current is passed through staged semi-conductor junctions arranged such that heat is removed at one set of junctions (providing the cooling) and rejected at the other. The freezer engineering data used were taken from Reference 184 and 177, which were obtained from catalogue data for commercial units. The reference weight and volume were given separately for the freezer locker and the thermoelectric devices. To keep the concepts on a common basis, the weight and volume of the locker were assumed equal to the locker for the space radiator concept #1.



CONCEPT Thermoelect	ric freez	ONCEPT REQUIR	EMENTS AND	PENALTIES CALC	ÜLATIONS INDEX NU	MBER 1. 1	. 3 . 2
(Ref.#184 p	4.6 - 4.12)			5 5 6 4 5 6 5			
	ELECIRI	•	<u>O W E R</u>	REQUIRE		POWE	
•	USE YIME CYCLE	A C  PEAK	O N E  AVERAGE	DEMAND (WATT-HR/	© D C PEAK	6 AVERAGE	DEMAND (WATT-HR/ CYCLE)
COMPONENT (REF)	(HR)	(WATTS)	(WATTS)	(D) x(3)	(WATTS)	(WATTS)	①x⑦
Thermoelectric devices, fans, illumination					570		
•							
	-				***************************************	•	•
		MANTANIN		TOTAL	<u>570</u> .		TOTAL
		MAXIMUM		TOTAL	MAXIMUM		, TOTAL
	•	•	•	1			-
		**************************************		• •			
	<u>I H</u>	ERMAL	REQUI	REMENTS			• ; : ***4; **
SOURCE		LATENT BTU/HR)		SIBLE J/HR)	HEAT LEAK (BTU/HR)		COOLANT BTU/HR)
Box heat leak	•	Λ .	-1	88	-188		0
Electrical power	<del></del>	0		83	456	egin of the second	1327
							• • • • • • • • • • • • • • • • • • •
	: <del></del> -			<del>,</del>		·	
	TOTAL	0		(1595)	(268)		(1327)
		T (BTU/HR)	WATT	(BTU/HR)	WATT (BTU/HR)	WAT	T (BTU/HR)
		•					
e double de la com							
	0.0.0						
	<u>vr</u> s	RATION	<u>AL PE</u>	NALTIES			
T. Source	HEAT LEA	THERMAL TO	COOLANT	ELECTRICAL		u\ /==	VOLUME
Source.	(BTU/HR/CYC	rf) (Rio)	HR/CYCLE)	(PK WATTS/CY	CLE) (LB/MISSIO	<b>1)</b>	(NOISSIM\ _E
		·	•••	-		<del></del> -	
	<del></del>					<del></del>	
							<del></del>
10 Maria 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	MATTS/CY (BTU/HR/C	CLE WAT CYCLE) (BTU	TS/CYCLE /HR/CYCLE)		KG/MISSION (LB/MISSION	N M ¹ N) (F1	/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED) CONCEPT Thermoelectric freezer INDEX NUMBER FIXED WEIGHT/VOLUME REQUIREMENTS WEIGHT (LBS) VOLUME (FT3) COMPONENT (REF) Thermoelectric devices 113 Freezer locker only 98.7" TOTAL (13.8) 212) KG (LBS) M3 (FT3) WI/YOL REQUIREMENTS SOLID EXPENDABLE VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT3) (PKG.WT/UNIT)(REF) WI/CYCLE VOL/CYCLE (LB) TYPE UNITS/CYCLE(REF)  $\overline{\Sigma @}$  $\overline{\Sigma}$   ${}_{f S}$ TOTAL WT/CYCLE (LB) TOTAL VOL/CYCLE (FT3) TOTAL WT. TOT.WT/CYCLE (LB) DAYS/MISSION KG (LB) TOTAL VOL DAYS/MISSION TOT.VOL/CYCLE M3 (FT3) CYCLES/DAY REQUIREMENTS 6 A S/L 1 Q U I D EXPENDABLES AMT LOST/CYCLE · ② AMT.RECOVERED/CYCLE 1 RECOVERY AMT. USED/CYCLE (REF) ① X ② (LB) **FACTOR** YPE  $\Sigma$  $\Sigma$  ①

TOTAL LOST/CYCLE (Z (1))

(LB)

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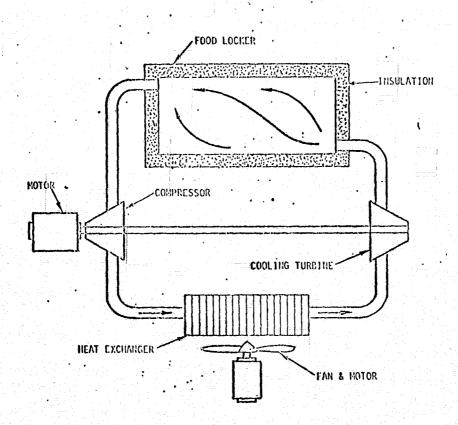
KG (LB)

DAYS/MISSION

CYCLE/DAY

SPACECRAFT_	Shuttle			
HABITABILIT	Y SUBSYSTEM_	Food Management	_HABITABILITY FUNCTION_	Food Storage
APPLIANCE F	UNCTION Fr	rozen Food Storag	ie .	
APPLIANCE C	CONCEPT NO./T	ITLE 3/Air-cy	cle turbine/compressor	
INDEX NO.	1.1.3.3	Andrew The American	REF. NO. 184	

DESCRIPTION: In this concept, air is alternately compressed and expanded in a closed refrigeration cycle. This concept was included for comparison since it represents a typical commercial aircraft system. In an aircraft, ram air is used to cool the heated working fluid, whereas in the spacecraft system a motor and fan are used.



concept Air cycle +	urbine/co	A.34 - A.46	freezer		INDEX N	UMBER 1.1.3.3
	FFFF	A C		<u>R E Q U I R E</u>	D C	POWER
COMPONENT (REF)	USE TIME CYCLE (HR)	② PEAK (WATTS)	3 AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE)  ① X ③	⑤ PEAK (WATTS)	(WATTS)  (b)  DEMAND (WATT-HR/ CYCLE) (WATTS)  (WATTS)
Compressor & fan		15,200				
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		15 000		•	· ·	
		15,200 MAXIMUM	•	TOTAL	MAXIMUM	TOTAL
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	· · · · · · · · · · · · · · · · · · ·				•	
	•	THERMAL'	REQUIR	EMENIS		
SOURCE		LATENT (BTU/HR)		IBLE /HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Box heat leak		0	-1	88	-188	0
Electrical power			13.3		5448	7950
	•			· · · · · · · · · · · · · · · · · · ·		
				<del>,</del>		
	TOTAL .	0		13,210)	(5260	(7950)
		WATT (BTU/HR)		BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)
		•				
	0	PERATION	AL PE	<u>NALTIES</u>		
		THERMAL				
SOURCE,	HEAT (BTU/HR/	LEAK TO	COOLANT /HR/CYCLE)	ELECTRICAL  (PK WATTS/CY		VOLUME  ON) (FT ³ /MISSION)
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			•			
	IOTAL HATT	S/CYCLE WA	TTS/CYCLE U/HR/CYCLE)		KG/MISSIC (LB/MISSIC	ON M ³ /MISSION (FT ³ /MISSION)

CONCEPT Air cycle	APPLIANCE CONC lurbine/comp	ept requirements as	ND PENALTIES CALCULAT		DER 1.1.3.2,
	• •	<b>*</b> · ·	e e e e e e e e e e e e e e e e e e e		
	FIXED	MEIGHT/VOF	· · · · · · · · · · · · · · · · · · ·	REMENIS	
COMPONENT	(REF)	)	WEIGHT (LBS)	•	VOLUME (FT ³ )
Freezer (	letal)		723	· · · · · · · · · · · · · · · · · · ·	135
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	TOTAL		(723)	1 [	(135)
			KG (LBS)	-J	Ma (LLa) .
	<u>SOLID EX</u>	<u>PENDABLE</u>	WT/VOL REQ	UIREMENTS	•
		<b>Ø</b>	<u> </u>		S VOL/CYCLE
TYPE	UNITS/CYCLE(REF)	WT/UNIT (REF) (PKG.WT/UNIT)(REI (LB)	(LB)	VOL/UNIT (REF) (PKG.VOL/UNIT)(REF (FT3)	(FT ³ )
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		${\Sigma}$		$\Sigma$	
		•	TOTAL WT/CYCLE . (LB)		TOTAL VOL/CYCLE (FT3)
TOTAL WI. =	x	X .	• • • • • • • • • • • • • • • • • • •	•	
	CLES/DAY C	DAYS/MISSION	TOT.WT/CYCLE (LB)		KG (LB)
TOTAL VOLCYC	CLES/DAY X	X DAYS/MISSION	TOT.VOL/CYCLE		M3 (FT3)
			TOT.VOL/CYCLE (FT3)		
	GAS/LIQUI	D EXPEND	ABIES REDU	LIREMENTS	
a The graduate plants by the Co The Common Common States of the Common States of the Common States of the Common States of the Common States of	ZHBELALL	<b>o</b>		T.RECOVERED/CYCLE	AMT LOST/CYCLE
TYPE	AMT. USED	CYCLE (REF)	RECOVERY AM	IT.RECOVERED/CYCLE  ① X②  (LB)	10-3 (LB)
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TOTAL WT.					
CYCLE	TOAY A DAYS/M	SSION TOYAL LO	ST/CYCLE (LB)	k (1)	KG (LB)

HABITABILITY SUBSYS	TEM 1.0	) Food Man	agement		
HABITABILITY FUNCTI	ON 1.2	Preparatio	n	· .	
APPLIANCE FUNCTION_	1.2.2	Warming			
NUMBER OF CONCEPTS	CONSIDERE	3	-		

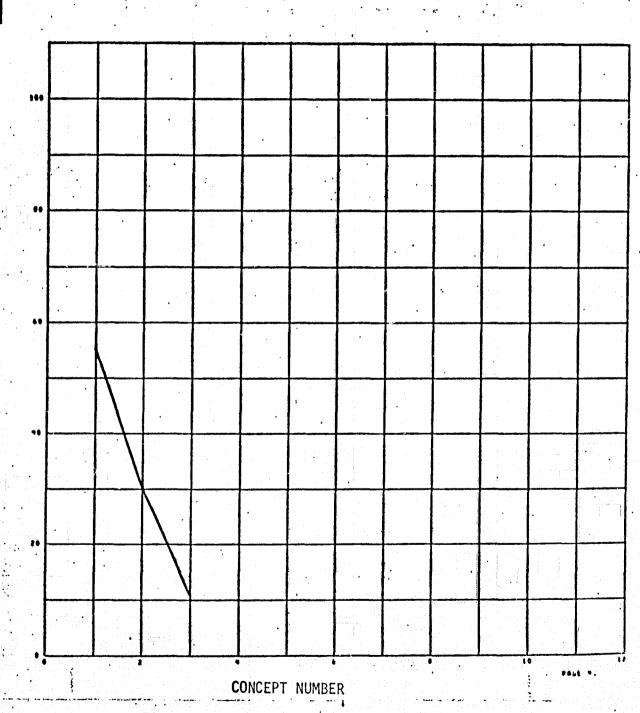
## **ASSUMPTIONS**

Since current planning in the spacecraft food system area does not include a requirement for cooking, the concepts considered in this section apply to food warming only and not cooking. In Reference 184, it is recommended, for planning purposes, to size ovens based on 80 percent of the maximum allotted frozen food per man-day. Based on the Skylab food mix which was assumed in this study (which contained approximately 100 lbs. of frozen food for 420 planned man-days), this would result in a warming unit sized for 0.24 lbs. per man. This value is obviously low, due to the relatively short supply of frozen food in Skylab. Therefore, the design value of 0.8472 lbs. and 0.1696 cu. ft. of food per man (Reference 184, 276) was assumed throughout this study to size the ovens. For Shuttle, the oven food capacity was therefore 3.4 lbs. and 0.68 cu. ft. Three meal warmings per 24 hours were assumed. To compare the food warming concepts on a common basis, the weight and volume of each food warming concept includes the weight and volume of the trays and tray rack associated with it.

				· · · · · ·	<u>. 11 i</u>				A -	PPLIA	NCE C	ONCEP	T FUN	CTION HA	TRIX		¥ .								
	INDI	EX NO	. 1.2.	2 ••	•• F	000	MARHI	NG_(S	SHUTTL	E)					<b></b>										
	CONCI		USAGE T:HE	ço	NSUMA	BLES	AND	FLOW	REQUI	REHEN	ITS	тн	ERHAL	REQHTS	ELI	EC PI	NR RECH	TS	₩ <b>T</b> ;V0	L_RE	QHTS		OPHENT OST	RES	PPLY
			ES/DAY	TYPE	ÜS	T.	FL.	• • • <u></u>	PRESS	TE	HP	coo	LANT	HT LEAK	A	C	AVG P		WEIGH	T V	LUME	AVAIL	INDEX (***)		 [GHT (G-
-	••••	••••		•••••		USE)_	••••	.)	Tb21g	) (DE	G_F)_	(BTU	/HR)_	-ZTTAW- (FH\UTB)	WA	!TS=.	WATT	S <u>-</u>	(LBS	1, (	U_FT1	•••••	••••		BS)
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		0, 1 - 2 - 3 -	HEAT OVEN	ON CING TREMOT.	AYS	SKYL	AB) T10N_ [N)	(ELE)	ADIRTO	L_HEA	\T)		(* 	1 - CABII 2 - CABII 3 - OXYG 4 - COOL 5 - WATEI 6 - HITR 7 - NITR 8 - FREOI 9 - WATEI	N AIR - EN ING WATE R DGEN DGEN	(L) (L) (C) (C) (C)	IRCULATE OST) OST) IRCULATE OST) IRCULATE SED) IRCULATE ROCESSED	D), I	KG/HR KG/HR KG/HR KG/HR KG/HR KG/HR	. !	(FT ³ /MI (LB/HR) (LB/HR) (LB/HR) (LB/HR) (LB/HR) (LB/HR) (LB/HR) (LB/HR)				
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Food Warming (Shuttle) Concept Trade

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_	NUMBER OF DAYS = 20.5 ( .06 YEARS)	
	THERMAL PENALTY - DIRECT TO COOLANT (18/8TUH) .0250	
_	THERMAL PENALTY - CABIN HEAT LEAK (LB/RTUH) -0550 POWER PENALTY (LBS/WATT) TYPE 1 .5300	
_	POWER PENALTY (LBS/WATT) TYPE 2 4300	<del></del>
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_	SELECTION MATRIX FOOD WARMING (SHUTTLE)	
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_	HIN HAX CONCEPT  FACTOR VALUE VALUE PTS 1 2 3	
<b>)</b> _		
	WEIGHT 54.300 82.9c 15 .42 5.17 .00 POWER	
כ כ	VOLUME 3.9000 4.8000 10 .00 1.88 .21	
_	THERMAL 36.960 128.70 15 10.69 7.50 00 00 RELIAB-Y .99947 .99997 5 2.09 .00 4.76	
<b>o</b> _	MAINTENC .99999 1.00000 5 4.28 .00 4.28	
	SAFETY .00000 1.0000 5 5.00 .00 .00	
o -	DEV COST 5.0000 30.000 15 12.50 .00 .00 .00 TOTAL PT .00000 85.000 85 47.05 25.75 9.24	<del></del>
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<b>O</b>	RATING .00000 100.00 100 55.35 30.29 10.88	
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		SENSITIVIT	V ANALYSIS		· · · · · · · · · · · · · · · · · · ·				
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APPLIANCE FUNCTION: 1.2.2-FOOD WARMING

			-	N	JMB	E R	0	F	C O	M P C	NE	N-T-S	·····		··		
COMPONENT TYPE	MOTOR	BLOWER	HEATER	RF. GEN.	CONTROLLER TIMER												NUMBER OF SAFETY CRITICAL ITEMS
PPLIANCE TYPE NO.	1	18	17	<b>®</b>	19	0	0	0	0	0	0	0	0	0	0	0	116/13
EATING TRAYS (SKYLAB) OT AIR CONVECTION (ELEC. HEAT) (pg. 5-2) ICROWAVE (PLAIN)(pg. 5-4)	1	1	1(3)* 1 -	- - 1	1 1 1										•	•	0 1
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Derated to 1 due to low temperature of three ht's.		· ·															
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SPACECRAFT	Shuttle	•	<del></del> ,		•	
<b>HABIT</b> ABILI	TTY SUBSYSTEM FO	od Management	_HABITABILI	TY FUNCTION_	Food	Preparation
APPLIANCE	FUNCTION Foo	d Wanning ·	x · · · ·	•	· · · · · · · · · · · · · · · · · · ·	
APPLIANCE	CONCEPT NO./TITI	E 1/Heating	Trays (Sky	lab)' "		}
INDEX NO	1.2.2.1		REF. NO	255, 276		· · · · · · · · · · · · · · · · · · ·

**DESCRIPTION:** In this concept, an insulated food tray with three heating cavities surrounded by imbedded electrical resistance heating elements is used. This concept was used on Skylab, and the actual Skylab weight/volume/power data were assumed. A heating time of  $1\frac{1}{2}$  to 2 hours is required to warm the food. Two hours was used for computing thermal penalties to the cabin cooling circuit.

Each Skylab heating tray weighed 10.9 kg (24 lb). However, of this total weight, 2.7 kg (6 lb) was a stainless steel bracket used for a working surface. To compare with the oven concepts, the weight/volume of this bracket was not included in the heating tray weight/volume. Instead, the data for a tray storage rack was taken from Reference 276 and added to the basic concept weight and volume. No separate dish tray penalty was added for this concept since the tray is already an integral part of the concept.

D2-118561-2 APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS INDEX NUMBER 1.2.2. CONCEPT Heating trays ELECTRICAL POWER REQUIREMENIS POWER POWER DEMAND (WATT-HR/ CYCLE) (1) X(3) (7) DEMAND USE TIME (2) (3) (5) 6 (WATT-HR/ CYCLE PEAK AVERAGE AVERAGE PEAK CYCLE) (HR) COMPONENT (REF) (WATTS) (WATTS) (WATTS) (WATTS) Weating element 394 (#255 MAXIMUM MAXIMUM TOTAL TOTAL THERMAL REQUIREMENTS TO COOLANT LATENT SENSIBLE HEAT LEAK (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) SOURCE Heating element (255) 672 672 TOTAL WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) ORIGINAL PAGE IS OF POOR QUALITY OPERATIONAL PENALTIES THERMAL TO COOLANT ELECTRICAL WEIGHT VOLUME (PK WATTS/CYCLE) (LB/MISSION) (FT3/MISSION) SOURCE. (BTU/HR/CYCLE) (BTU/HR/CYCLE)

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r,							
		7					
	N	/A			• •		

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

INDEX NUMBER 1,2.2

COMPONENT Total tray (les	(REF	) .		WEIGHT (LBS) 72	• •	•	VOLUME (FT³)
Rack	(#2.76)	 		8.6-			2.5
		- - -					
			•			•	
							• : -
	TOTAL	· . <u>`</u> [		(80.6) KG (LBS)		М	(4,8) 13 (FT3)
		PENDAB WT/UNIT	_	I/V O L R I	QUIREME (4)		VOL/CYCLE
TYPE N/A	UNITS/CYCLE(REF)	PKG.WT/U	NIT)(REF) B).	①×② (LB)	VOL/UNIT (PKG.VOL/U (FT ³	NIT)(REF)	① x ④ (FT³)
							•
		-	Σ3	TOTAL WT/CYCI	.E	Σ ⑤	TOTAL VOL/CYCLE
TOTAL WT. = CYCL	ES/DAY X	DAYS/MISSION	X	TOT.WT/CYCLE (LB)		ĸ	G (LB)
MISSION =	ES/DAY X	DAYS/MISSION	x				2 /
	ES/DAY (			TOT.VOL/CYCLE (FT ³ ) :			1 ³ (FT ³ )
	<u>6 A S/L 1 Q U 1</u>		ENDAB	LES RES	QUIREMEN.		<b>a</b>
TYPE	AMT.USED,	① 'CYCLE(REF) (LB)		ECOVERY FACTOR	AMT.RECOVERED/C	YCLE	AMT LOST/CYCLE  1 - 3 (LB)
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		•	• • • • • • • • • • • • • • • • • • • •				
	Σ ①					Σ@ _	
TOTAL WT		•	•	_		• [	

SPACECRAFT	Shuttle		· · · · · · · · · · · · · · · · · · ·		•	
HABITABILI	TY SUBSYSTEM_	Food Managem	ent HABİTABI	LITY FUNCTION	N Food Pr	reparation
APPLIANCE	FUNCTION Foo	od Warming				···
APPLIANCE	CONCEPT NO./1	ITLE 2/0ve	n-hot air conv	<u>vection-elec</u>	tric	· · · · · · · · · · · · · · · · · · ·
INDEX NO	1.2.2.2		REF. NO	. 276		·

**DESCRIPTION:** This concept resembles a conventional electrical oven with resistance heating elements. Oven size is based on the requirement in Section 1.2.2 of 0.0193 cu m (0.68 cu ft) of food per meal: A heating time of 0.5 hours was used, with an additional 0.5 hours allowed for the oven heat to dissipate to the cabin gas. Thus, a total time of 1 hour was assumed for computing the thermal penalty to the cabin cooling circuit.

CONCEPT Oven - hot	air Conve	ince concept requi	tric		INDEX	NUMBER 1, 2.	2.2
(Ref. #276)		T D 1 C A L		B F A H I B F	WENT C		
		IRICAL E	<u>POWER</u> C. POWE	REQUIRE	D C	POWER	•
•	USE TIME			DEMAND			(7) DEMAND
	CYCLE	② PEAK	③ AVERAGE	(WATT-HR/	⑤ PEAK	<b>(</b> ) AVERAGE	(WATT-HR
COMPONENT (REF)	(HR)	(WATTS)	(WATTS)	CYCLE)	(WATTS)	(WATTS)	CYCLE)
Total electrical	0.5.			-	858	686	343
		-		-			
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			•		858		343
		MAXIMUM		TOTAL	MAXIMUM		TOTAL
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				•			
•			•	•			
		IHERMAL	REQUI	REMENTS			
•		LATENT	SEA	ISIBLE	HEAT LEAK	TO C	OOLANT
SOURCE		(BTU/HR)		U/HR)	(BTU/HR)		U/HR)
Total electrica	}	^ .		170	1170	•	9
Iofal electric	11			110			
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	TOTAL	0	343	(1170)	343 (1170)	<u> </u>	0
	•	WATT (BTU/HR)	WATT	(BTU/HR)	WATT (BTU/HR)	WATT	(BTU/HR)
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		OPERATIO	NAL PI	NALTIES	•		
		THERMAL		CI CCTD10AI	Ne tous	•	ı tive
SOURCE,	HEA (BTU/H	NT LEAK TO R/CYCLE) (BTO	D COOLANT U/HR/CYCLE)	ELECTRICAL (PK WATTS/C)			LUME MISSION)
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	TOTAL						

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED) concept Oven - hot air convection - electric INDEX NUMBER 1.2.2. (Ref.#276) WEIGHT/VOLUME FIXED REQUIREMENTS WEIGHT (LBS) VOLUME (FT³) COMPONENT ·(REF) 28.6 Oven Tray rack 20.0 travs rack TOTAL (54.3)3.9 KG (LBS) M3 (FT3) REQUIREMENTS W T/V O L SOLID EXPENDABLE MT/CYCLE ①,X② VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³) WT/UNIT (REF)
(PKG.WT/UNIT)(REF)
(LB). (1) TYPE UNITS/CYCLE(REF)  $\overline{\Sigma}$  $\overline{\Sigma}$   ${}_{ar{\mathbb{S}}}$ TOTAL WT/CYCLE
· (LB) TOTAL VOL/CYCLE (FT3) TOTAL WT. = DAYS/MISSION TOT.WT/CYCLE (LB) CYCLES/DAY KG (LB) TOTAL VOL -TOT.VOL/CYCLE (FT3) CYCLES/DAY DAYS/MISSION M3 (FT3) GAS/LIQUID EXPENDABLES REQUIREMENTS 0 AMT LOST/CYCLE AMT.RECOVERED/CYCLE 0 RECOVERY AMT. USED/CYCLE (REF) ① X ② (LB) TYPE FACTOR (LB)  $\Sigma$  (4)  $\Sigma$  ① TOTAL WT. TOTAL LOST/CYCLE DAYS/MISSION CYCLE/DAY KG (LB)

(E (1)

(LB)

SPACECRAFT Shuttle			
HABITABILITY SUBSYSTEM Food	Management HABITABILI	TY FUNCTION	Food Preparation
APPLIANCE FUNCTION Food War	ming	· ·	
APPLIANCE CONCEPT NO./TITLE_	3/Oven-Microwave		
INDEX NO. 1.2.2.3	REF. NO	276	

DESCRIPTION: This concept resembles a conventional microwave oven. Oven size is based on the requirements described in Section 1.2.2 of 0.0193 cu m (0.68 cu ft) of food per meal. A heating time of 10 minutes was assumed, with an additional 0.5 hours allowed for the oven heat to dissipate to the cabin gas. Thus, a total time of 40 minutes was assumed for computing the thermal penalty to the cabin cooling circuit.

(Ref. #276)						
	ELECI		<u>OWER</u> , POWE	REQUIRE	MENIS DC	POWER
OMPONENT (REF)	USE YIME CYCLE (HR)	② PEAK (WATTS)	3 AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) (1) X (3)	⑤ PEAK (WATTS)	(WATT-HF AVERAGE CYCLE) (WATTS)
Heater .	1/6.	2745	2745	458	1	
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		2745.		458 TOTAL	MAXIMUM	TOTAL
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	_	HERMAL	KEANT	REMENTS.		
SOURCE	•	LATENT (BTU/HR)		SIBLE U/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
Heater		<u> </u>	_2:	340	2340	
						<u> </u>
		0	196	(22/10)	696 (234	o) O
	TOTAL _	WATT (BTU/HR)	WATT	(2340) (BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)
		•				
	<u>o</u>	PERATION	AL PE	NALTIES		
		THERMAL		ELECTRICAL	WEIGHT	VOLUME
SOURCE.	HEAT (BTU/HR/	LEAK TO CYCLE) (BTU/	COOLANT HR/CYCLE)	(PK WATTS/CY		
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CONCEPT Oven -		UIREMENTS AND PENALTIES CAN	LCULATIONS (CONCLUDED)  INDEX NUM	BER 1, 2.2.3
	<u>Elxed Wel</u>	GHT/VOLUME RE	QUIREMENIS	
COMPONENT Oven total Tray rack Serving tra	(REF)	WEIGHT (LBS) 57.2 5.7 20.0		volume (F13) 2.9 1.8 led in rack)
	TOTAL	KG (LBS)	7)	(4.7) M³ (FT³)
ТҮРЕ	SOLID EXPEND  WIT/ (PKG.	<u>ABLE WI/VOL</u> ② . ③ UNIT (REF) WT/CYC! WT/UNIT)(REF) ① X② (LB). (LB)	) (PKG.VOL/UNIT)(RE	YOL/CYCLE F) ①X ④ (FT³)
TOTAL WT. = CYC	XX	Σ3 (LB)  x τοτ. ωτ/cycli	•	TOTAL VOL/CYCLE  (FT3)  KG (LB)
TOTAL VOL =	LES/DAY X DAYS/MIS	X (LB)		M ³ (FT ³ )
ТҮРЕ	AMT. USED/CYCLE (R	0	AMT.RECOVERED/CYCLE ① X ② (LB)	AMT LOST/CYCLE  O-3 (LB)
TOTAL WT. MISSION CYCLE	Σ ①x	X TOTAL LOST/CYCLE CZ (2)	Σ ④ 	KG (LB)

HABITABILITY SUBSYSTEM	1.0	Food Management
HABITABILITY FUNCTION_	1.3	Galley Cleanup
APPLIANCE FUNCTION	1.3.1	Dishwasher/Dryer Combination
. NUMBER OF CONCEPTS CONSID	ERED	10

#### **ASSUMPTIONS**

All the automatic dishwashing data found have been for single integrated washer/dryer units. All the dishwasher engineering data used for Space Station were used directly for Shuttle also after adjusting for a crew size of four men (Space Station crew was six men). Therefore, only the total values for each penalty are shown in the following data sheets. Each penalty is 4/6 times the corresponding Space Station penalty. For an itemized breakdown of the various penalties, the Space Station data sheets in Appendix C should be consulted.

Three washings per day were assumed, with 4.53 kg (10 lbs) of water used for washing and 4.53 kg (10 lbs) for rinsing. It is assumed that 0.093 kg (0.20 lb) of residual water remains on the dishes after rinsing to be removed by the dryer.

The amount of dishes required by the crew, assuming an automatic dishwasher/dryer is aboard, was computed and included with the washer/dryer penalty. This was necessary to compare with the disposable dishes case in Section 1.3.2. The packaged weight and volume of the dishes were taken directly from Section 1.3.2 and the results shown in Table B2-3. The total dishes/utensils/cups required with the dishwasher for a four-man crew is 4.10 kg (9.03 lbs) and 0.014 cu m (0.49 cu ft).

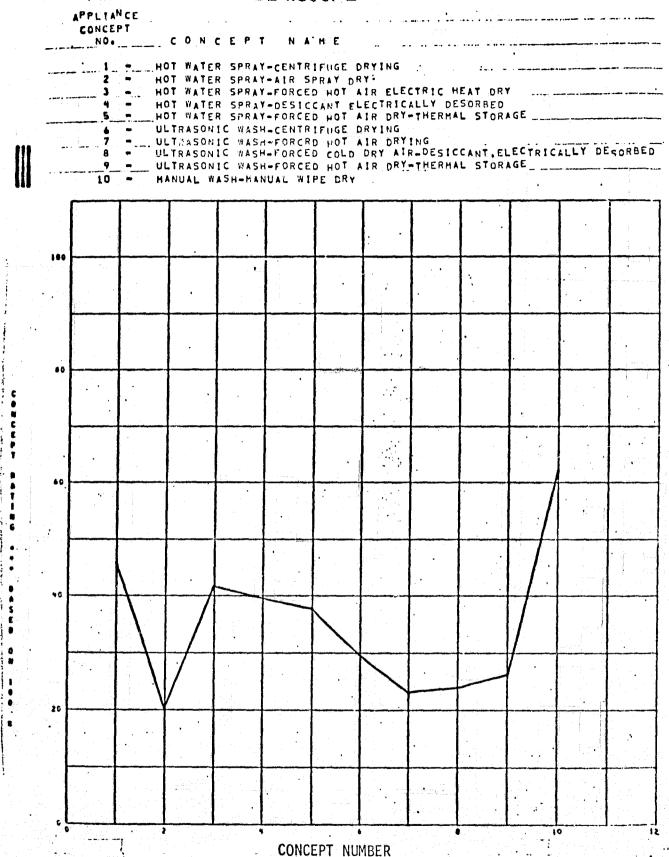
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	NO.	CONCE	PTN	AHE		· · · · · · · · · · · · · · · · · · ·	<del></del>	-			- CABIN AIR	(CIRCULATED	), LITERS/S	EC (FT3/MIN)	
<del>[]</del>	1 -	HOT WATER S	PRAY-CEN	TRIFUGE OR	VING	<del></del>	<del></del>	<del></del>	<del></del>		- CABIN AIR - OXYGEN	(LOST) (LOST)	, KG/HR , KG/HR	(LB/HR) (LB/HR)	
	_z	HOT MATER S	PRAY-AIR	SPRAY DRY	برايد ليبا	 <u>ლები</u> ლადა "			· · · · · · · · · · · · · · · · · · ·	4	- COOLING WATE	R (CIRCULATED	)) KG/HR	(LB/HR)	
	3 -	HOT WATER S HOT WATER S									- WATER - NITROGEN	(LOST) (CIRCULATED	, KG/HR	(LB/HR) (LB/HR)	
	5 •	HOT MATER S	PRAY-FOR	CED HOT AL	R DRY-T	HERMAL	STORAGE .				- NITROGEN - FREON	(USED) (CIRCULATED	KG/HR	(LB/HR) (LB/HR)	
	7 •	ULTRASONIC: ULTRASONIC	WASH-FOR	CRD HOT AT	R DRYIN	G			· · · · · · · · · · · · · · · · · · ·	9	- WATER	(PROCESSED)	KG/HR	(LB/HR)	
	8 -	ULTRASONIC_ ULTRASONIC	WASH-FOR	CED_COLD_D	RY_AIR=	DESICCA		ICALLY D	ESORBED	<del></del>					
	10 -	HANUAL RASH				neunat	SIUNAGE			· · · · · .		•	(***)***		
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B2-63



Dishwasher/Dryer Combination (Shuttle) Concept Trade

NUMBER OF DAYS = 20°5 ( °06 YEARS)

USES HOD SUBROUTINE 23

THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) •0250

THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) •0550

POWER PENALTY (LB/WATT) TYPE 1 •5300

POWER PENALTY (LBS/WATT) TYPE 2 •4300

### SELECTION MATRIX . . . . DISH WASHER/DRYER COMBINATION (SHUTTLE)

(01/25/75)

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	THERMAL	46 - 475	169.12		1.20_	•00	1.20_ 9.63	10.42	10-18	8 - 14	6.88	. 6 • 99	10-17	10.80	<del></del>	•
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APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 1.3.1-DISHWASHER/DRYER COMBINATION (PAGE 1 OF 2)

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COMPONENT TYPE	© MOTOR	PUMP	VALVE SOLENOID	ACCUMULATOR	WATER SEPARATOR	TRANSMISSION (GEAR BOX)	FILTER	HEAT EXCHÁNGER	CONTROLLER TIMER	BLOWER AIR	HEATER DC	DESFCCANT CANISTER	THERMAL STORAGE UNIT	ELECTROACOUSTIC TRANSMISSION	HIGH FREQUENCY CONTROLLER		NUMBI OF SAFET	TY CAL
APPLIANCE TYPE NO.	1	2	3	4	6	7	9	6	(19)	18	7	21)	0	15)	(4)	0	ITEMS	<b>.</b>
HOT WATER SPRAY WASHING, CENTRIFUGE DRYING (pg. 98)	2	1	2	2	1	1	1	-	1	-	4	-	-	-	-		• 1	
HOT WATER SPRAY WASHING, AIR SPRAY DRYING (pg. 100)	1	1	2	2	1	-	1	1	1	1	-		. <b>-</b>	-	-		0	
HOT WATER SPRAY WASHING FORCED HOT AIR ELECTRIC HEAT DRYING (pg. 102)	2	1	2	2	1	1	1	1	1	1	1	- -	-	<b>-</b> ',	-	· -	2	
HOT WATER SPRAY WASHING, FORCED COLD AIR-DESICCANT, ELECTRIC DESORBED (pg. 104)	2	1	3	2	1	1	1	1	1	1	1	1	-	-	-		1 ·	
HOT WATER SPRAY WASHING, FORCED HOT AIR DRYING USING THERMAL STORAGE (pg. 107)	2	1	2	2	1	1	1	1	1	1	-	1	1	-	-		2	
ULTRASONIC WASHING, CENTRIFUGE DRYING (pg. 109)	2	1	2	2	1	1	1	-	1	-	_	-	. <b>-</b>	1	i		2	
ULTRASONIC WASHING, FORCED HOT AIR ELECTRIC DRYING (pg. 111)	2	1	2	2	1	1	1	1	1	1	1	1	-	1	1		- 3	
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D2-118561-2

### APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 1.3.1-DISHWASHER/DRYER COMBINATION (CONCLUDED) (PAGE 2 OF 2)

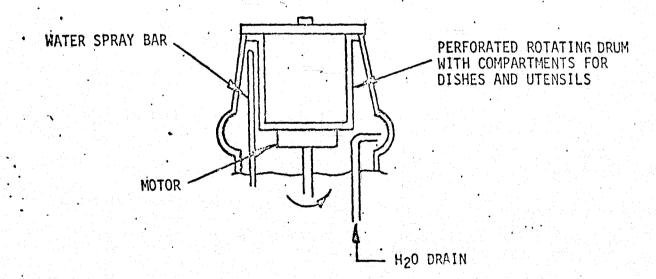
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COMPONENT TYPE  APPLIANCE TYPE  NO.	—) Моток	⊕ PUM <b>P</b>	SOLENOID	(+) ACCUMULATOR	(SEPARATOR	TRANSMISSION (GEAR BOX)	©F1LTER	(EXCHANGER	© CONTROLLER TIMER	® BLOWER AIR	(1) HEATER	DESICCANT CANISTER	THERMAL STORAGE	ELECTROACOUSTIC TRANSMISSION	HIGH FREQUENCY CONTROLLER	0	NUMBER OF SAFETY CRITICAL ITEMS
ULTRASONIC WASHING, FORCED COLD DRY AIR-DESICCANT, ELECTRICALLY DESORBED (pg. 115)	2	1	2	2	1	1	1	1	1	1	1	<u></u>	-	1	1		2
ULTRASONIC WASHING, FORCED HOT AIR DRYING USING THERMAL STORAGE (pg. 117)	2	1	2	2	1	1	1	1	1	1	1	<b>-</b>	•	1	1		3
MANUAL WASH-MANUAL WIPE (pg. 119)	1	1	2	1	-	-	-	-	-	-	-	-	-	-	-		0
(2.3.3. SINK)							•				•			•			•
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### D2-11856172

SPACECRAFT_	Shuttle	
HABITABILITY	Y SUBSYSTEM Food Management HABITABILITY FUNCTION Cleanu	р
APPLIANCE FU	UNCTION Dishwasher/Dryer Combination	
APPLIANCE CO	ONCEPT NO./TITLE 1/Hot Water Spray Wash-Centrifuge Dry	
INDEX NO.	1.3.1.1 REF. NO. 90	· ·

#### DESCRIPTION

In this concept, washing is accomplished by spraying hot water (with an 8 psig pump head) over the dishes in a slowly rotating drum. Drying is assumed to be accomplished simply by centrifugal force at high speed rotation. This concept is included in the trades since conceptual data are available; however, the drying method is unproven and doubtful.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS concept Hot water spray - centrifuge drying INDEX NUMBER 1. 3. 1. 1 POWER ELECTRICAL REQUIREMENTS POWER DC POWER DEMAND (WATT-HR/ CYCLE) (1) X (7) USE_TIME DEMAND (WATT-HR/ CYCLE) (1) X (3) (2) (3) (5) 6 AVERAGE AVERAGE CYCLE PEAK PEAK (WATTS) COMPONENT (REF) (HR) (WATTS) (WATTS) (WATTS) Motor. Pump 50 100 MAXIMUM TOTAL MAXIMUM TOTAL REQUIREMENTS THERMAL HEAT LEAK SENSIBLE TO COOLANT LATENT (BTU/HR) (BTU/HR) SOURCE (BTU/HR) (BTU/HR) o for (drying TOTAL WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) OPERATIONAL PENALTIES THERMAL TO COOLANT (BTU/HR/CYCLE) ELECTRICAL VOLUME **WEIGHT** HEAT LEAK (PK. WATTS/CYCLE) (LB/MISSION) (FT3/MISSION) SOURCE (BTU/HR/CYCLE) TOTAL WATTS/CYCLE (BTU/HR/CYCLE) M3/MISSION (FT3/MISSION) WATTS/CYCLE (BTU/HR/CYCLE) KG/MISSION (LB/MISSION)

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APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT Hot water spray - centrifuge dry

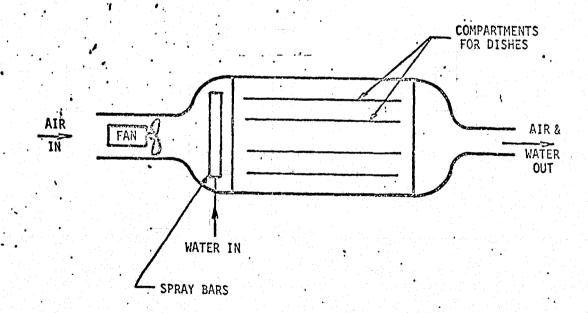
INDEX NUMBER 1. 3. 1. 1

	FIXED	<u>W E I G H I/V</u>	OLUME REQ	UIREMENI	<u>s</u>	χ, :
COMPONENT Basic wash	er/dryer	· · ·	WEIGHT (LBS)		Yı ('	OLUME
Pump		<del></del>	*			
Z Accumulat Velvina	101-5	· · · · · · · · · · · · · · · · · · ·		<del></del>		
Water com	ator		•	<del> </del>		
Packaoina				•		
- the house of the late of the	sels/cups	Negative	<u> </u>	•		
Total		•		•		
		[			<del></del>	7.3.3.1
	TOTAL	L	33.5 (74.	0)	0.47	7 (16.9)
	4		KG (LBS)		W ₃	(FT ³ )
•	SOLID EXI	<u>PENDABLE</u>	WI/VOL R	EQUIREM	ENTS	
					ENIS (A) OIT (REF) /UNIT)(REF) T ³ ) D27	VOL/CYCLE
	①	Ø WT/UNIT (RE (PKG.WT/UNIT) (LB)	(REF) UX (LB)	(PKG. VOL	/UNIT)(REF)	① X ④ (FT³)
Detergout/	UNITS/CYCLE(REF)	·010	.012	() 00.	029	.00035
germicide	-	(.012	)	.00	035	
germie	· · · · · · · · · · · · · · · · · · ·			<del></del>		
						<del></del>
						<del></del>
	Na tier armen (gaage as a filler a film), byer you de discussions as an a	**************************************				
	· · · · · · · · · · · · · · · · · · ·		$\Sigma$ 3 .012		Σ⑤_	.00035
			TOTAL WT/CY	CLE		TOTAL VOL/CYCL
TOTAL WT. =	3 x 2	20.5	x .012	<b>#</b>	0.3	(0.7)
CYC	LES/DAY D	AYS/HISSION	TOT.WIZCYCLE (LB)		KG	(LB)
TOTAL VOL =						
MISSION CYC	LES/DAY D	QO.5 AYS/MISSION	X .00035 TOT.VOL/CYCLE (iT3)	<u> </u>	0.000 6	
			(iT3)		•	
	G A S/L I Q U I I	<u> </u>	<u>DABLES</u> <u>RE</u>	Q U I R E M E	<u>N T S</u>	
		0	0	(3) AMT.RECOVERED	I/CYCLE	MT LOST/CYCLE
ТҮРЕ	AMT. USED/	CYCLE(REF) LB)	RECOVERY FACTOR	① X ② (LB)	, 3, 3, 3	① - ③ (LB)
Wash wat		0	O	·O		10.
Rinse wat	er 1	0	1.0	10		0
						-
		<del></del>	<del>,</del>		<del></del>	
	$\Sigma$ 0 _2	0			$\Sigma$ @	10.
		. •				-
MISSION 3	x 20		10. 61	5 + 2	0 . 2	88 (635)
CYCLE	7DAY DAYS/MI	SSION TOTAL	I.OST/CYCLE	n\	<b>A</b>	KG (LB)

SPACECRAFT Shuttle	
HABITABILITY SUBSYSTEM Food Management HABITABILITY FUNCTION_	Cleanup
APPLIANCE FUNCTION Dishwasher/Dryer Combination	
APPLIANCE CONCEPT NO./TITLE 2/Hot Water Spray-Air Spray Dry	,
INDEX NO. 1.3.1.2 REF. NO. 90	

### DESCRIPTION

The washing function for this concept is identical to that used in Concept 1. Drying is accomplished by a high-velocity air spray (30 fps) sufficient to drive the water droplets off the dishes. Thus, the drying air is not heated.



	ELEC	IRICAL P	OWER RE	<u>Q U 1 R E M</u>	<u>ENTS</u>		
•	_	. A.C.	. POWER		D C	POWER	
	USE TIME CYCLE REF) (HR)	PEAK (WATTS)	WATERVOR (	DEMAND WATT-HR/ CYCLE)  ① X ③	5 PEAK (WATTS)	⑥ AVERAGE (WATTS)	(7) DEMAN (WATT-H CYCLE) ① X (7
Valves .		· ·		·			
<u>Fan</u>		<del></del>	<del> </del>			<del></del>	
Pump				<del></del>			
				· · · · · · · · · · · · · · · · · · ·	<del></del>		<del></del>
•	-					<del></del>	·
<del>,</del>							
		900			50		
		MAXIMUM		TOTAL	MAXIMUM .		ATOT
	e e e e e e e e e e e e e e e e e e e	•					
	• 1	The State of the S	•	•			
		<u>I H E R M A L</u>	REQUIRE	MENTS			
•	•	THEVHUE	VEXXITE.				
		LATENT	SENSIBL		HEAT LEAK		COOLANT
SOURCE		(BTU/HR)	(BTU/HR	)	(BTU/HR)	(B	TU/HR)
Water heat	1,50 (40°F)						
	11122 ( 121 )	The second secon	*	•		,	
Pump		•	<del> </del>	<del></del> . •			
Fan			<del></del>		•	<u> </u>	
Water Clry	ring)		•	<del></del>			
				·		<del></del>	
	TOTAL	62(212)	901 (30	75)	901 (3075	)	0
		WATT (BTU/HR)	WATT (BTU		WATT (BTU/HR)		(BTU/HR
			·. ·				•
		•					•.
						et sakti	
		<u> </u>	AL PEN	LIIES			
		THERMAL			WEIGHT		OLUME
SOURCE		THERMAL TO	COOLANT	LIIES ELECTRICAL EK WATTS/CYCL	WEIGHT		
SOURCE		THERMAL TO	COOLANT	ELECTRICAL			
SOURCE		THERMAL TO	COOLANT	ELECTRICAL			· /MISSIO
SOURCE		THERMAL TO	COOLANT	ELECTRICAL			
SOURCE		THERMAL TO	COOLANT	ELECTRICAL			/MISS101
SOURCE		THERMAL TO	COOLANT	ELECTRICAL			/MISSIO
SOURCE		THERMAL TO	COOLANT	ELECTRICAL			/MISSIO
SOURCE		THERMAL TO	COOLANT	ELECTRICAL			· /MISSIO
SOURCE	(BTU/	THERMAL  EAT LEAK TO  YHR/CYCLE) (BTU	COOLANT	ELECTRICAL		ON) (FT ³	/MISSION

concept Hot water spray - Air Spray Dry INDEX NUMBER 1.3.1.2

	FIXED	WEIGHT/YO	LUME ·RE	QUIREMEN	<u>T S</u>	¥.,
COMPONENT	(REF)		WEIGHT (LBS)			VOLUME (FT3)
Basic wash Pump	er/dryer_			·		· · · · · · · · · · · · · · · · · · ·
2 Accumula	tors					
Valving Water servi	raist	•				
Fan Packaning				<del></del> ,	*******	
Dishes/utin	sels/ cups	•				
Total						
	TOTAL	3	1.5 ( 69. :	3)	0.515	(18.2)
	•	, ·	KG (LBS)	=:		1 ³ (FT ³ )
	SOLID EXE	PENDABLE	W T/V O L	REQUIRE	MENIS	•
TYPE	① UNITS/CYCLE(REF)	WT/UNIT (REF) (PKG.WT/UNIT)(F	③ WT/CYC (EF) ① X ② (LB)	LE VOL/ ) (PKG.V	MENTS  (4)  UNIT (REF)  OL/UNIT)(REF)  (FT3)	⑤ VOL/CÝCLE ① X ④ (FT³)
Detergent/				· · · · · · · · · · · · · · · · · · ·		
<u>germicide</u>	· · · · · · · · · · · · · · · · · · ·					
**************************************						
	· · · · · · · · · · · · · · · · · · ·	<u> </u>			Σ⑤	
			TOTAL WT/ (LB)	CYCLE	<b>_</b>	TOTAL VOL/CYCLE (FT3)
TOTAL WT. = CYC	3 LES/DAY X DA	20.5 x	TOT.WT/CYCL	= F	0.3	( 0.7)
TOTAL VOL			(LB)	•		
TOTAL VOL = CYC	3 LES/DAY XDA	20.5 NYS/MISSION X	TOT.VOL/CYC	LE	0.0006	3 (0.02)
			(FT ³ )			
	<u>G A S/L I Q U I I</u>	<u>EXPENC</u>	<u> </u>	<u>EQUIREM</u>	<u>E N T S</u>	
		<b>D</b>	② RECOVERY	AMT.RECOVER ①X	) ED/CYCLE	AMT LOST/CYCLE
TYPE	AMT. USED/O		FACTOR	(LB	2)	(LB)
Wash water Rinse water	<del></del>	<u> </u>	0			
		<u></u>				
					*	
	ΣΦ2	)			Σ⑩	10
TOTAL WT 3	x 20.	5 x 1	0		20 • [	288 (635)
CYCLE	ZDAY DAYS/MIS	STON TOTAL I	OST/CYCLE		z ①	KG (LB)

### D2-11856172

Food  HABITABILITY SUBSYSTEM Management HABITABILITY FUNCTION Galley Cleanup  Appliance Function Dishwasher/Dryer Combination	
Anni Mar rugarron Dichuzchor/Dryon Combination	
APPLIANCE FUNCTION Dishwasher/Dryer Combination	
APPLIANCE CONCEPT NO./TITLE 3/Hot Water Spray Wash-Forced Hot Air Electric Hea	t Dry
INDEX NO. 1.3.1.3 REF. NO. 90	

### DESCRIPTION

The washing function for this concept is identical to that used in Concept 1. Washing is accomplished by spraying hot water (with an 8 psig pump head) over the dishes in a slowly rotating drum. Drying is accomplished by a circulating flow of air over the dishes which is heated by an electrical heating element. The heater also heats the dishes by radiation. Heater size is based on a 1 hour drying time.

	Water	spray .	wash - f	utrements and forcec ho	enalties calculated air	LATIONS , INDEX N	JMBER 1.2	.1.3
	lectric 1	neat dr		<u>P 0 H E R</u>	<u>R E Q U I R E </u>			
		. (1)		C . POWE	R (4)	D C	POWE	R (7)
•		USE TIME	2	3	DEMÂND (WATT-HR/	<b>⑤</b>	6	(7) DEMAND (WATT-HR,
		CYCLE	PEAK	AVERAGE	CYCLE)	PEAK	AVERAGE	CYCLE)
COMPONENT	(REF)	(HR)	(WATTS)	(WATTS)	Фх@	(WATTS)	(WATTS)	①x⑦
Yalxing.	<del></del>							
Fan	·	<del></del>	<del></del>		<del>. , . ,</del>			
Motor Heater								
Pump								
						·		
						<u></u>		<del>,</del>
					San	2.10		
	•					217		
		• •	MUMIXAM		TOTAL	MAXIMUM		TOTAL
	•							
		•						
							•	
			TUEDWAL	0 5 0 11 7 1	D			
			THERMAL	KEAOT	REMENIS			
			LATENT	SEN	SIBLE	HEAT LEAK	TO	COOLANT
SOUR	CE		(BTU/HR)		U/HR)	(BTU/HR)	.: (1	STU/HR)
Pump							•	
Water hea	+ 1055(1	45°F)		<u> </u>	<del> </del>			
<u>Fan</u>							<u>1</u>	
Motor			- 1				- 1	
Heater		<del></del>			•			
	<del></del>	<del></del>		<del></del> -	<del></del>			
Water	drying)	<u> </u>		<del>-</del>				
		rowa.	62 (212	)		248 (845	) 165	(561
		rotal '	WATT (BTU/HR)	 WΔTT	(BTU/HR)	WATT (BTU/NR)		(BTU/HR)
			WALL (BIO) III.		(BIO/IIK)	WALL (010/1-1)	WAL	(BIO/NK)
		•						
								and L
		(	<u>PERATI</u>	DNAL ¹ PE	NALTIES			
		•						
		HEAT	THERMA LEAK	TO COOLANT	. ELECTRICAL	WEIGHT		VOLUME
SUI	IRCE	(BTU/HR		BTU/HR/CYCLE)	(PK WATTS/CYC	CLE) (LB/MISSI	ON) (FT	3/MISSION)
300	. 1 .							
	V / A				•			
	7-7-1	•	· 大大大海山)。				<u> </u>	
							•	
		TAL WAT!	TS/CYCLE	WATTS/CYCLE		KG/MISSI	)N M3	/MISSION

B2-76

concept Hot water spray wash - Forced hot air	ONCLUDED) INDEX NUMBER 1. 3. 1. 3
electric heat dry	
FIXED WEIGHT/VOLUME REQUIREME	15
CCMPONENT (REF) (LBS)	VOLUME (FT ³ )
Basic washer larger	4
Pump 2 Accumulators	
Valvino :	
Water separater	
<u>Fau</u>	
Packaging	
Dishes / winsols / cups	
/8781	
TOTAL 39.9 (88)	7.7 (16.9)
KG (LBS)	м³ (FT³)
SOLID EXPENDABLE WIVOL REQUIR	
② ③	(E) (DL/UNIT (REF) VOL/CYCLE (E) (D. VOL/UNIT) (REF) (D. X (4) (FT3) (FT3)
(PKG.WT/UNIT)(REF) ①X② (PKG.TYPE UNITS/CYCLE(REF) (LB) (LB)	(FT ³ ) (REF) (1) X (4) (FT ³ )
Deteracit/	
germicide	
3-5-6-6-6-6-6-6-6-6-6-6-6-6-6-6-6-6-6-6-	
$\Sigma$	Σ ⑤
TOTAL WIZCYCLE	TOTAL VOL/CYCLE (FT3)
(LB)	
TOTAL WT. X X X	0.3 (0.7)
CYCLES/DAY DAYS/MISSION TOT.WT/CYCLE (LB)	KG (LB)
TOTAL VOL = x x x	0.00063 (0.02)
CYCLES/DAY DAYS/MISSION TOT.VOL/CYCLE  (FT3)	M ³ (FT ³ )
일본 시간 시간 시간 기가 되는 이 그 그 때문에 되어 생각하는 것 같	
<u>GAS/LIQUID</u> <u>EXPENDABLES</u> <u>REQUIRE</u>	<u>M E N T S</u>
AMT.USED/CYCLE(REF)	)X②
	(LB)
Wash water	
Kinse watch	
$\Sigma$ $\odot$	Σ @
기정으로 열어 보면 지난 사람이 아름이 있습니다. 생각 사람들이 나왔다고 있다고 있다.	
TOTAL WT X X	- 288 (635)
CYCLE/DAY DAYS/MISSION TOTAL LOST/CYCLE (22 (1)) (LB)	(z ①

B2-76.1

<b>SPACECRAFT</b>	Shuttle			• •	•			
HABITABILI	Food TY SUBSYSTEM Mana		- _HABITABI	LITY F	UNCTION_	Galle	ey Cleanup	p
APPLIANCE	FUNCTION Dishwas	her/Dryer Co	pbination					
<b>APPLIANCE</b>	CONCEPT NO./TITLE	4/Hot Water	Spray Wa	sh-For	ced Cold	l Air E	Des <b>ic</b> cant	Dry
INDEX NO	1.3.1.4		_REF. NO	·	90			
DECCRIPTION								

#### DESCRIPTION

In this concept, washing is accomplished by spraying hot water over the dishes in a slowly rotating drum. A fan is used during washing and rinsing to transport air and excess water out of the washer. The same fan is used to circulate air through the dishes for drying. The air is routed through a desiccant bed upstream of the dryer to dry the air first; thus, no additional heat is assumed necessary. The desiccant is desorbed using an electrical resistance heater sized for a 1 hour desorption time.

	FFF	IRICAL !	POWER	REQUIRE	MENTS		
		A (	· .	R	D C	POWE	R
•	USE TIME	2	3	DEMAND	(5)	6	(7) DEMAND (WATT-HR
	CYCLE	PEAK	AVERAGE	(WATT-HR/ CYCLE)	PEAK	AVERAGE	(WATT-HE
OMPONENT (REF)	(HR)	(WATTS)	(WATTS)	OXO	(WATTS)	(WATTS)	CYCLE)
Motor.	•		1"				
Fan							
Valves							
Pump				<del></del>			
Heater		•					-
						<del></del>	
		·					
		• •		**********			
		116			97		
	•	MAXIMUM		TOTAL	MAXIMUM		TOTAL
	• 1					***	
		THERMAL	REQUI	<u>R E M E N T S</u>	•		. •
		LATENT	SEN	SIBLE	HEAT LEAK	то	COOLANT
SOURCE (BTU/HR)		(BTU/HR)		(BTU/HR)		BTU/HR)	
and the state of the					ang Salat Paris		
Water heat loss	(40°F)					<u> </u>	
n mp							<del> </del>
Motor							
Fan							
					<del></del>		•
Heater	<del></del> •					• 1	
. Water (drying)	TOTAL	62 (212)	246	(839)	246 (839)	65	5 (221
	IUIAL	WATT (BTU/HR)		(BTU/HR)	WATT (BTU/HR)		T (BTU/HR)
		WALL COLONIAL		(0.0/1)	man (broythay	11/21	1 (DIO)IN)
			• •	• 11			
	•	•					
		OPERATIO	NAL PE	NALTIE	<u>s</u> '		
		THERMAL					
		AT LEAK T	O COOLANT	ELECTRICA			VOLUME
SOURCE	(BTU/I	IR/CYCLE) (BI	U/HR/CYCLE)	(PK WATTS/C	YCLE) (LB/MISSIC	)N) (FI	L3/WISSION)
N/A							
						<del></del>	
and a second of the second of the second	ATAI			and the second second	ana na 1886 an iliya	- 1 March	
	OTAL	TTS/CYCLE V	ATTS/CYCLE	· · · · · · · · · · · · · · · · · · ·	KG/MISSIO (LB/MISSIO	N	3/MISSION

B2-78

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

concept Hot water spray wash - Forced cold air desiccant INDEX NUMBER 1.3.1.4 WEIGHT/VOLUME REQUIREMENTS WEIGHT (LBS) VOLUME (FT3) (REF) COMPONENT Basic Pump Accumia Valvina Water separator Desiccant Packaging Dishes/ utinsels/enps TOTAL 37.5 M3 (FT3) KG (LBS) " EXPENDABLE W T/V O L <u>REQUIREMENTS</u> SOLID VOL/UNIT (REF)
(PKG.VOL/UNIT)(REF)
(FT³) ②
WT/UNIT (REF)
(PKG.WT/UNIT)(REF)
(LB) ①x② (LB) UNITS/CYCLE(REF) Detergent Germicide  $\overline{\Sigma \mathfrak{G}}$ TOTAL VOL/CYCLE (FT3) TOTAL WT/CYCLE (LB) TOTAL WT. MISSION 0.7)
KG (LB) TOT.WT/CYCLE (LB) DAYS/MISSION TOTAL VOL MISSION 0.00063(0.02 M3 (FT3) DAYS/MISSION CYCLES/DAY REQUIREMENIS GAS/LIQUID MT.RECOVERED/CYCLE

(LB) AMT LOST/CYCLE 0 RECOVERY AMT. USED/CYCLE(REF) FACTOR (LB) Wash water  $\Sigma$  (1)  $\Sigma 0$ TOTAL WT. MISSION TOTAL LOST/CYCLE (z (d) DAYS/MISSION (LB) (z (1)

## D2-11856F-2

SPACECRAFT Shuttle	
Food HABITABILITY SUBSYSTEM Management	HABITABILITY FUNCTION Galley Cleanup
APPLIANCE FUNCTION Dishwasher/Dryer C	Combination
APPLIANCE CONCEPT NO./TITLE 5/Hot Water	Spray Wash-Forced Hot Air Dry-Thermal Storage
INDEX NO. 1.3.1.5	REF. NO. 90
DESCRIPTION	
In this concept, washing is accomplished pump head) over the dishes in a slowly representating a flow of air over the dia thermal storage unit which stores heat to heat the inlet air.	rotating drum. Drying is accomplished shes. Washer water is routed through

oncept Hot water ther	mal stora	on - Force	d hot	air dry	INDEX NO	MBER 1.3.1.5
<b>ካ</b> ከደነ	* * * * * * * * * * * * * * * * * * * *		DWER !	REQUIRE	MENIS	
•		. A C		₹	" D.C	POWER
•	USE TIME	<b>②</b>	3	DEMAND (WATT-HR/	(5)	6 DEMAND
	CYCLE	PEAK	AVERAGE	(WATT-HR/		AUTDACE (WATT-HR)
OMPONENT (REF	) (HR)	(WATTS)	(WATTS)	CYCLE)	(WATTS)	(WATTS) CYCLE)
Valves.	<u> </u>					
Motor				سسم جميد حضائيت يند	-	
Pump		<del></del>				
Fan			<del></del>			
		-				
					48	
	•	_12_4_				
•		MUMIXAM		TOTAL	MAXIMUM .	TOTAL
		•	• 1 - 1 - 1			
			•			
		THERMAL	REQUIR	EMENIS		
		LATENT	SENS	TRI F	HEAT LEAK	TO COOLANT
SOURCE		(BTU/HR)	(BTU		(BTU/HR)	(BTU/HR)
Pump			<del>بدر بدر</del>			
Motor	general en en en el e El en el					
Fan	<u> </u>					
Water/thermo	storage			<u> </u>		
				,	, ,	
	TOTAL	62 (212)	370	1263)	170 (581)	262 (895
		WATT (BTU/HR)	WATT (	BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)
	<u>.</u>	<u> </u>	AL PE	NALTIES		
		THERMAL		ELECTRICAL	WEIGHT	VOLUME
SOURCE	HEAT (BTU/HR		COOLANT HR/CYCLE)	(PK WATTS/CY		
N/A				·		
						•
		<del>nie diipan</del> t <del>salik</del> Kalifanisi				
						그렇게 하는 사람들이 가장 없었다.
	TOTAL	IS/CYCLE WAT	TS/CYCLE (		KG/MISSIO (LB/MISSIO	N M3/M1SS10N

ONCEPT Hot water	APPLIANCE CONCERT REQUEST Spray wash	ulrements and penalyles ca - Forced hot all	neculations (concluded) r dry - Index n	UMBER 1.3.1.5
thermal				
•		GHI/VOLUME RE WEIGHT (LBS)	QUIREMENIS	VOLUME (FT3)
omponent Basic washer/c	(REF)	(1.62)		(11")
Pump /	155			
Valving	Jen			
Weter separa				
Thermal store	<del></del>			
Dishes/atensil	s/crps			
	TOTAL	50.3 (11)	, ,	8.2 (17.9)
		KG (LBS) &		M ³ (FT ³ )
<u>s</u> <u>o</u>	LID EXPEND	ABLE WI/VOL	REQUIREMENTS	
		② ③ UNIT (REF) WT/CY WT/UNIT)(REF) ① X( (LB) (LB	)	(BEE) VOL/CYCLE
	ITS/CYCLE(REF)	(LB) (LB	) (PKG. VOLY 0411)	(REF) (1) X (4) (FT3)
Detergent/ germicide				
<del> </del>			A CONTRACT OF THE CONTRACT OF	
		$\sum \mathfrak{J}$	/CYCLE	TOTAL VOL/CYCLE (FT3)
TOTAL WT. =	en en skriver i de skriver Skriver en skriver	1 4 7 1 <b>x</b>	· · · · · · · · · · · · · · · · · · ·	.3 (0.7)
CYCLES/D	DAYS/MIS	SION TOT.WT/CYC (LB)	LE TOTAL TOT	KG (LB)
TOTAL VOL = CYCLES/D	X DAYS/MIS	X TOT VOL (CY	- Q. O.	0063 (0.02) M ³ (FT ³ )
Cicesio	MI DAIS/IIIC	SSION TOT. VOL/CY (FT ³ )		
	AS/LIQUID I	<u> XPENDABLES</u>	REQUIREMENTS	
	0	0	AMT.RECOVERED/CYCLE	AMT LOST/CYCLE
Turkey	AMT.USED/CYCLE(F	REF) RECOVERY FACTOR	① x ② (LB)	①-③ (LB)
Wash water Rinse water			<u>ja koja koja koja koja je </u>	
	1			
	30		$\sum_{i} c_i$	<u> </u>
305 Budala <b>4</b>	. · · · · · · · · · · · · · · · · · · ·			
TOTAL WT				: 288 (635)

SPACECRAFT Shuttle Food HABITABILITY SUBSYSTEM Management	HABITABILITY FUNCTION Galley Cleanup
APPLIANCE FUNCTION Dishwasher/Di	ryer Combination
APPLIANCE CONCEPT NO./TITLE 6/Ulti	rasonic Wash-Centrifuge Dry
INDEX NO. 1.3.1.6	REF. NO90

#### DESCRIPTION

This concept is identical to Concept 1 except that ultrasonic cleaning is used to clean the dishes instead of a high velocity water spray. No ultrasonic energy damping is assumed. Drying is assumed to be accomplished by centrifugal force at high speed rotation. The concept is included in the trades since conceptual data are available; however, the drying method is unproven and doubtful.

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS INDEX NUMBER 1. 3. 1. 6. CONCEPT Ultraionic wash-centrifuge drying ELECTRICAL POWER REQUIREMENTS POWER POWER (7)
DEMAND
(WATT-HR/
CYCLE)
(1) X(7) USE TIME DEMAND (2) (3) (5) **6** (WATT-HR/ CYCLE) ①X③ CYCLE PEAK AVERAGE PEAK AVERAGE COMPONENT (HR) (WATTS) (WATTS) (WATTS) (WATTS) (REF) Valves: Pump Motor HE acherator MAX I MUM TOTAL MAXIMUM TOTAL THERMAL REQUIREMENTS TO COOLANT LATENT SENSIBLE HEAT LEAK (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) SOURCE Water heat loss (40°F) Pump generador Motor Water 62 (212 TOTAL WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) PENALTIES OPERATIONAL THERMAL TO COOLANT VOLUME - ELECTRICAL WEIGHT HEAT LEAK (FT3/MISSION) SOURCE (PTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION)

M³/MISSION (FT³/MISSION)

KG/MISSION (LB/MISSION)

WATTS/CYCLE (BTU/HR/CYCLE)

TOTAL

WATTS/CYCLE (BTU/HR/CYCLE) APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT Ultrasonic wash - Centrifuge drying INDEX NUMBER 1.3.1.6

OMPONENT (REF	WEIGHT (LDS)		VOLUME (FT³)
Basis washer/dryer		1	
Pump : 1			
2 Accumulators Valvina			وبنيوس ويبنيون والمراجع
Water separator			
Controller		•	
Packaging			
Dishes / ulensils/ cups			
Total			
		<del></del>	<del></del>
TOTA	40.5 (89.	2)]	50 (17.5)
	KG (LBS) 6		M ³ (FT ³ )
	Ku (LB3) &		M- (F1-)
<u>SOLID EX</u>	PENDABLE WI/YOL R	EQUIREMENTS	
	Ø ③ WT/UNIT (REF) WT/CYCLE	<b>(4)</b>	S ) VOL/CYCLE.
<b>①</b>	(PKG.WT/UNIT)(REF) $(1) X (2)$	VOL/UNIT (REF (PKG.VOL/UNIT)( (FT ³ )	) VOL/CYCLE. REF) ① X ④ (FT³)
TYPE UNITS/CYCLE(REF)	(LB) (LB)	(FT ³ )	(FT3)
Detergent/		<del></del>	
germicide		<del></del>	
and the second s			<del></del>
			<del></del>
•			
	Σ3	Σ	<u> </u>
	TOTAL WT/CYC	CLE	TOTAL VOL/CYCLE (FT3)
OTAL WT. = X			
CYCLES/DAY X	DAYS/MISSION X TOT.WT/CYCLE	_ • 0.	3 (0.7) KG (LB)
	(LB)		
TOTAL VOL _ X	<b>x</b>	. 0.00	0063 (0.02)
CYCLES/DAY	DAYS/MISSION TOT. VOL/CYCLE (FT3)	<del></del>	M ³ (FT ³ )
<u> </u>		QUIREMENTS	
	0	AMT.RECOVERED/CYCLE	AMT LOST/CYCLE
AMT. USED	/CYCLE(REF) RECOVERY	①x② (LB)	(1) - (3)
	(LB) FACTOR	(LB)	(LB)
Wash water		· · · · · · · · · · · · · · · · · · ·	
	أنجاب بجانيه بمستنال استبرجتنب		
			🖍 in the Principles of the Control
Σ٠		$\Sigma$ (	·
ICTAL NY X		<u>2</u> 0	

### D?-118561-2

SPACECRAFT Shuttle	
HABITABILITY SUBSYSTEM Manage	ement HABITABILITY FUNCTION Galley Cleanup
APPLIANCE FUNCTION Dishwasher	r/Dryer Combination
APPLIANCE CONCEPT NO./TITLE_	7/Ultrasonic Wash-Forced Hot Air Electric Dry
INDEX NO. 1.3.1.7	REF. NO. 90
DESCRIPTION	
Ultrasonic cleaning is used to	o clean the dishes, with no ultrasonic energy

Ultrasonic cleaning is used to clean the dishes, with no ultrasonic energy assumed lost due to damping. Drying is accomplished by a circulating flow of air over the dishes which is heated by an electrical heating element. The heater also heats the dishes by radiation. Heater size is based on 1 hour drying time.

concept Ultrasonic wash - Forced hot air electric dry INDEX NUMBER 1.3.1.7. POWER REQUIREMENTS ELECTRICAL POWE POWER DEMAND (WATT-HR/ USE TIME (4) DEMAND (5) 6 2 3 (WATT-HR/ CYCLE PEAK AVERAGE PEAK AVERAGE CYCLE) CYCLE) (WATTS) (WATTS) COMPONENT (REF) (HR) (WATTS) (WATTS) Valves . Motor Healer Tan HF concarator Pensi MAXIMUM TOTAL MAXIMUM TOTAL REQUIREMENTS THERMAL TO COOLANT LATENT SENSIBLE HEAT LEAK (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) SOURCE acherator 1511 TOTAL WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) OPERATIONAL PENALTIES VOLUME ELECTRICAL WEIGHT HEAT LEAK TO COOLANT (PK WATTS/CYCLE) (LB/MISSION) (FT3/MISSION) SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE)

A.

WATTS/CYCLE (BTU/HR/CYCLE) M³/MISSION (FT³/MISSION)

KG/MISSION (LB/MISSION)

TOTAL

WATTS/CYCLE (BTU/HR/CYCLE) concept Ultrasonic wash - Forced hot air electric dry index number 1.3.1.7

component (RE Basic washer/dryer		T/VOLUME R WEIGHT (LBS)	EQUIREME	<u>N I S</u>	VOLUME (FT ³ )
			<del></del>	1	
Z. Accumulators					
Valvina	<del></del>	<del></del>	<del></del>		
Weter separater	······································	•	<del></del>		· · · · · · · · · · · · · · · · · · ·
Fan	<del></del>				
Controller					
Peckagina					
Dishes/Ufonsils/ cups		, . <del></del>	-		
Tetal					
тот	AL [	44.5 ( 9:	3)	L	6 (17.9) 13 (FT3)
<u>\$ 0 L 1 D</u> <u>E</u>	X P E N D A B		REQUIR	EMENIS	æ\
TYPE UNITS/CYCLE(REF	WT/UNIT (PKG.WT/U ) (L	(REF) WT/C NIT)(REF) ①X B) (L	③ YCLE VO (PKG B)	(REF) VOL/UNIT (REF) (FT3)	(5) VOL/CYCLE (1) X (4) (FT 3)
Detergent/	<del></del>				
germicide					
	·				
			<del></del>		
		<del></del>			
		Σ3	IT (CVC) F	$\Sigma$ (§	TOTAL VOLVEYOUR
		101/1C W	IT/CYCLE B)	•	TOTAL VOL/CYCLE (FT3)
TOTAL WT. = X				03	( \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \
CYCLES/DAY X	DAYS/MISSION	TOT.WT/CY	CLE	0.3	(0.7)
		(LB)			
TOTAL VOLXXX	DAYS/MISSION	XX	YCLC	0.000	63(0.02)
		(FT3)	•		
<u>G A S/L I Q U</u>	<u>ID EXP</u>	ENDABLES	REQUIRE	MENTS	
		0	and the second second		•
	①	RECOVERY	AMT . RECOV	③ ERED/℃YCLE X ② LB)	AMT LOST/CYCLE  1 - 3 (LB)
TYPE	D/CYCLE(REF) (LB)	FACTOR	$^{\cup}$	LB)	(LB)
Wash water					
Rinse water					
	<u> </u>		- 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1		
$\Sigma$ $\bullet$				$\Sigma$ @ _	
TOTAL WT. X		<b>\</b>		. [	288 (635)
CYCLE/DAY DAYS	MISSION Y	OTAL LOST/CYCLE	<del></del>		288 (635) KG (LB)
		OTAL 1.0ST/CYCLE (z 4)	(LB)	(左 ①	

SPACECRAFT Shuttle	· 				
· · · · · · · · · · · · · · · · · · ·	Food Management	HABITABILITY	FUNCTION_	Galley	Cleanup
APPLIANCE FUNCTION Dishwa	asher/Dryer C	ombination .		<del></del>	<del></del>
APPLIANCE CONCEPT NO./TIT	LE <u>8/Ultraso</u>	nic Wash-Forced	Cold Dry	Air-De	siccant,
INDEX NO. 1:3.1.8		REF. NO. 90		ically l	Desorbed

#### DESCRIPTION

Û,

Ultrasonic cleaning is used to clean the dishes, with no ultrasonic energy assumed lost due to damping. Drying is accomplished by air circulated first through a desiccant bed where it is dried; thus, no additional heat is assumed necessary. The desiccant is desorbed using an electrical heater sized for a 1 hour desorption time.

oncept <u>Ultrasonic</u> · electricall	y desor	bed RICAL	<u> </u>	<u>R E Q U I R E</u>		• -	
omponent (REF) Volves Motor Tump Fan	USE TIME CYCLE (HR)		C POWE  3  AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) (1) X (3)	D C PEAK (WATTS)	POWE  6 AVERAGE (WATTS)	R  DEMAND  (WATT-HR  CYCLE)  () X(7)
Heater. HEgenerator		167 MAXIMUM		TOTAL	97 MAXIMUM		TOTAL
source Water heat loss (		THERMAL  LATENT (BTU/HR)	SEN	REMENIS SIBLE U/HR)	HEAT LEAK (BTU/HR)		COOLANT BTU/HR)
Pump HF generator Motor Irater/for/wat		62 (212)			451 (154)	1) 6	5 (22
		WATT (BTU/HR)  DPERAILO		(BTU/HR) . <u>N A L I I E S</u>	WATT (BTU/HR	WAT	T (BTU/HR)
source N/A		THERMAL T LEAK	TO COOLANT TU/HR/CYCLE)	ELECTRICAL (PK WATTS/CV	. WEIGH		VOLUME T ³ /MISSION
	TOTAL	TS/CYCLE I	WATTS/CYCLE BTU/HR/CYCLE)		KG/MISS (LB/MISS	10N M	³/MISSION T³/MISSION

WATTS/CYCLE (BTU/HR/CYCLE)

concept VItrasonic wash - Forced cold dry air - desiceant, INDEX NUMBER 1.3.1.8

CONDONE NA	iner	•	WEIGHT		•	VOLUME
COMPONENT Basic washer/d	(REF)		(LBS)			(FT3)
Pump	1-7-2-			1		
2 Accumulators				,		
Valving					<del></del>	
Water separator		· · · · · · · · · · · · · · · · · · ·		•	******	
Fan						
Controller						
Packaging.						
Dishes Julinsels/	: <u> </u>					
	TOTAL		43 (95)	<del></del>	8.7	(19.2)
		<b>I</b>	KG (LBS)			1 ³ (FT ³ )
	·					
<u>s o r</u>	<u> 1 D                                  </u>	NDABLE		<u>R E Q U I R E E</u>		
		WT/UNIT (REF)	MI/CYCL	E VOL/U	(A) UNIT (REF) UL/UNIT)(REF) (FT3)	VOL/CYCL <b>E</b>
TYPE UNITS	① (1 /CYCLE(REF)	PKG.WT/UNIT)(R	EF) ①X② (LB)	(PKG.VC	OL/UNIT)(REF)	(L13)
Petergent/						
germicide			<del></del>			i km i nikeji. Nili. <u>Lista i ji ka </u>
	*					
•	•		<del></del> -			<del></del>
		Σ	3		$\sum_{i=1}^{n} \overline{S}_{i}$	
		·	TOTAL WT/C	YCLE		TOTAL VOL/CYCLE (FT3)
OTAL WT. = MISSION =					0.3	
CYCLES/DAY	DAYS,	MISSION	TOT.WT/CYCLE		10.50	(°, 7)
OTAL VOL			(LB)			
OTAL VOL CYCLES/DAY	X	X /MISSION	TOT HOLLOWER	<b>*</b>	0.0000	3 (0.02)
CTCLES/DAT	UATS,	,1,112210H	TOT. VOL/CYCL (FT3)			P (P)-3
					A many	
<u>G</u> A	S/L I Q U I D	<u>EXPEND</u>	ABLES R	<u>EQUIREM</u>	NIS	
			0	er Creative III in the contract of		<b>@</b>
	(U) AMT.USED/CYC	_E(REF)	RECOVERY	AMT. RECOVERI ① X (7 (LB)	D/CYCLE	AMT LOST/CYCLE  (1)-(3)
TYPE	AMT.USED/CYCI		FACTOR	(LB)		①-③ (L3)
Rinse water				· ——————		
BIRS WILL		····				
		,				
				<u> </u>		
	<del></del>	<del></del>				
$\Sigma$ (	) <u> </u>	<del></del>		A CANAL IS	Σ ④ _	
OTAL WT.					<b>.</b>	20011
OTAL WT MISSION	X DAYS/MISSIO		OST/CYCLE -		"	288 (635)
GICELYDAY	MUTAVITABIL	IUINE 1	( <u>(</u> )) (	LB) (z	: ①	as trul

SPACECRAFT Shuttle		
Food HABITABILITY SUBSYSTEM Management	HABITABILITY FUNCTI	ON Galley Cleanup
APPLIANCE FUNCTION Dishwasher/Dryer Co	ombination .	······································
APPLIANCE CONCEPT NO./TITLE 9/Ultrason	ic Wash-Forced Hot A	ir Dry-Thermal Storage
INDEX NO. 1.3.1.9	REF. NO90	
DESCRIPTION		
Ultrasonic cleaning is used to clean the assumed lost due to damping. Drying is air over the dishes. Washer water is rewhich stores heat to be used during the	accomplished by circouted through a ther	culating a flow of mal storage unit

. thermal	storage	RICAL	POWER	<u>R E Q U 1 R E</u>	MENIS		
$\mathbb{E}_{n_1}(g) = \mathbb{E}_{n_2}(g)$	_	. Λ	C POWE	R	" <u>D C</u>	POWER	
COMPONENT (REF)	USE TIME  CYCLE  (HR)	PEAK (WATTS)	(WATTS)	DEMAND (WATT-HR/ CYCLE) ①X③	⑤ PEAK (WATTS)	⑥ AVERAGE (WATTS)	DEMAND (WATT-HR CYCLE) ① X ②
Valves  Motor  Pump  Fan  HF generator							
		167 MAXIMUM		TOTAL	48 MAXIMUM		TOTAL
		HERMAL	REQUI	<u>R E M E N T S</u>			
SOURCE		LATENT (BTU/HR)		SIBLE U/HR)	HEAT LEAK (BTU/HR)		COOLANT (U/HR)
Pump HF generator							
Motor Fan Water/thermalst	orage.						
·	TOTAL	62 (2/2) WATT (BTU/HR)		(1263) (BTU/HR)	170 (581) WATT (BTU/HR)		2 (89 (BTU/HR)
		PERATIO  THERMAL		ENALTIES ELECTRICAL			OLUME
SOURCE	(BTU/HR/	CYCLE) (B	TU/HR/CYCLE)	(PK WATTS/C	(LB/MISSI	ON) (FT³	/MISSION
							•
		<del></del>					<u>. 1 1 . 5 . 5 . 5 . 5 . 5 . 5 . 5 . </u>

CONCEPT LIATER SONIC Wash - Forced hot air dry - INDEX NU	MBER 1.3.1.9
thermal storage	
ELXED HELGHT/VOLUME REQUIREMENTS	
componen: (REF) WEIGHT (LBS)  Basic washer/dryer	VOLUME (FI³)
Pump Valvina	
2 Accumulators	
Water separator	
Fan Thermal storage unit	
Controller	
Packaging Dishes/utensils/cups	
TOTAL 57.1 (126) 70	
KG (LBS)	M³ (FT³)
SOLID EXPENDABLE WIVYOL REQUIREMENTS	
SOLID EXPENDABLE WI/YOL REQUIREMENTS  O WT/UNIT (REF) WT/CYCLE  VOL/UNIT (REF)  TYPE UNITS/CYCLE(REF)  (PKG.WT/UNIT)(REF)  (LB)  (FT3)	AOT ACACTE  (2)
TYPE UNITS/CYCLE(REF) (PKG.WT/UNIT)(REF) (PKG.VOL/UNIT)(REF) (LB) (PKG.VOL/UNIT)(REF) (PKG.VOL/UNIT)(REF)	EF) (1) X (4) . (FT ³ )
germicide .	
	engap ayan angan ana ana angan angan ayan angan an
	· · · · · · · · · · · · · · · · · · ·
$\Sigma$ 3 $\overline{}$ TOTAL WT/CYCLE (LB)	(FT3)
TOTAL WT. = X X = 0.3	
CYCLES/DAY DAYS/MISSION TOT.WT/CYCLE (LB)	KG (LB)
TOTAL VOL =	0063(0.02)
CYCLES/DAY DAYS/MISSION TOT. VOL/CYCLE (FT3)	NP (FIT)
아는 선생님들이 얼굴 보인다는 목사이에 되었다고 하시다면 모르는 사람들이다.	
GAS/LIQUID EXPENDABLES REQUIREMENIS	
	AMT LOST/CYCLE
AMT. USED/CYCLE (REF) RECOVERY AMT. RECOVERED/CYCLE  (1) x (2)	A:4T LOST/CYCLE ①-(3) (L3)
TYPE (LB) FACTOR (LB) Wash water	
Rinse water	
$\Sigma$ $_{\odot}$	
IOTAL NT X X	[288 (635)]
MISSION CYCLE/DAY DAYS/MISSION YOTAL TOST/CYCLE (LB) (CD)	(288 (635)

SPACECRAFT	Shuttle Food					
HABITABILI	Food ITY SUBSYSTEM Manac	iement	 HABITABILI	. · TY FUNCTION_	Galley	Cleanup
APPLIANCE	FUNCTION Dishwasho	er/Dryer Co	mbination			
APPLIANCE	CONCEPT NO./TITLE_	10/Manua 1	Wash-Manual	Wipe Dry		
INDEX NO	1.3.1.10		REF. NO	90		

#### DESCRIPTION

In this concept, the dishes are sealed in a Teflon bag equipped with a rubber glove on both sides. The crewman manually scrubs the dishes by fitting his hands into the gloves. When washing is completed, excess water is squeezed out of the bag and the dishes are wiped dry with a towel. It is assumed, according to Reference 90, that 0.136 kg (0.3 lb) of water is wiped by the towel, and that a clothes dryer is available to dry the towel. For this purpose, clothes dryer concept 3.3.2.1 (forced hot air-electric) was assumed. Since the clothes dryer penalties were based on removing 0.454 kg (1.0 lb) of water, the penalties for that concept were multiplied by 0.3 and added to this dishwasher/dryer concept.

		ELECTRICAL POWER REQUIREMENTS  AC. POWER DC F						POWER	
OMPONENT Towe	(REF) Dryer.	USE YIME CYCLE (HR)	PEAK (WATTS)	③ AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) ① X ③	⑤ PEAK	6 AVERAGE	DEMANI IATT-HI CYCLE)	
			14.7		TOTAL	45 MAXIMUM		TOTAL	
Vater 1	ource heat loss dryer		HERMAL  LATENT (BTU/HR)	SEN	REMENIS	HEAT LEAK (BTU/HR)	TO COO!		
•		TOTAL .	WATT (BTU/HR)	WATT	(BTU/HR)	235 (806) WATT (BTU/HR)	39 () WATT (B	1 <u>35</u> TU/HR)	
		<u>0</u>	<u> </u>	<u> </u>	<u>ENALILES</u>				

WATTS/CYCLE (BTU/HR/CYCLE)

WATTS/CYCLE (BTU/HR/CYCLE) KG/MISSION (LB/MISSION) M³/MISSION (FT³/MISSION) concept Manual wash - Manual wipe dry index number 1.3.1.10

	sher er scls/cups		(LOS)		1	(FT)
		• • • • • • • • • • • • • • • • • • •				
		in programme		•		
		•	<del></del>			
	<ul> <li>Solution</li> </ul>	-				······································
			***************************************			
						<del></del>
-0		· ( )				
PAGE IS	TOTAI		17.9 (39 KG (LBS)	7.3)	0.31	(10.7) N ³ (FT ³ )
	SOLIO EX	PENDABL (2)	E M I/A O F	REQUIRE	<u>MENIS</u>	<b>®</b>
	0	PENDABL  WIT/UNIT (R  (PKG.WIT/UNIT  (LB)	(3) (REF) WT/CY (REF) (DX)	CLE VOLA (PKG.)	M E N I S  (4)  (4)  (7)  (7)  (7)  (8)  (8)  (9)  (9)  (1)  (1)  (1)  (1)  (1)  (1	(5) VOL/CYCLE (1) X (4)
TYPE Defense	UNITS/CYCLE(REF)	(LB)	(LB	7	(FT ³ )	① X ④ (FT³)
Detergent/ germicide	*					
- germiciae		•				
		- <del></del>				
		-	$\Sigma$ 3	TOVOLE	$\sum \overline{\mathbb{S}}$	70731 700 7000
			TOTAL WI	)	$\mathcal{A}$	TOTAL VOL/CYCLE
OTAL WT.	<b>x</b>		_ x	•	0.3	(0.7)
CYCL	ES/DAY (	DAYS/HISSION	TOT.WT/CYC (LB)	LE	i	KG (LB)
MISSION =	<b>Y</b>			<b>.</b>	0.0000	63(0.02)
CYCL	ES/DAY 1	NOTES IN LEVA	TOT. VOL/CY (FT ³ )	CLE	1	MJ (FTJ)
	<u>G A S/L I Q U I</u>	n fypr	N D A B L E S	REQUIREM	FNTS	
			<b>2</b>			@
	AMT. USED.	O CYCLE (REF)	RECOVERY	AMT. RECOVER ① X (	ED/CYCLE	ANT LOST/CYCLE
Wash wate		CYCLE (REF)	FACTOR	(Li	Ŋ	①-③ (L8)
Wash water				- <del></del> -	ند ، <u>دند دید</u>	
				<u> </u>		
	Σ (0)				$\overline{\Sigma}$	
OTAL WY.	DAY X TAYS710	X	n. T.osy/cycle			288 (635)

HABITABILITY SUBSYSTEM	1.0	Food Management	
HABITABILITY FUNCTION	1.3	Cleanup	
APPLIANCE FUNCTION	1.3.1	Dishwasher/Dryer with	Disposables
NUMBER OF CONCEPTS CONSI	DERED	12	

#### **ASSUMPTIONS**

All the automatic dishwashing data found have been for single integrated washer/dryer units. Three washings per day were assumed, with 4.5 kg (10 lbs) of water used for washing and 4.5 kg (10 lbs) for rinsing. It is assumed that 0.09 kg (0.20 lb) of residual water remains on the dishes after washing to be removed by the dryer. Washing time and drying time are each assumed to be one hour.

The amount of dishes required by the crew, assuming an automatic dishwasher/dryer is aboard, was computed and included with the washer/dryer penalty. This was necessary to compare with the disposable dishes. The packaged weight and volume of the dishes were taken from the disposable dishes study (see results in Table B2-5). The total dishes/utensils/cups required with the dishwasher for a four-man crew is 4.6 kg (10.13 lbs) and 0.023 cu m (0.81 cu ft).

The four highest rated dishwasher/dryer concepts from the trade studies performed for appliance function 1.3.1 were selected to trade with eight of the highest rated disposable dishes cases.

D2-118561

Dishwasher/Dryer with Dishes (Shuttle) Concept Trade

										<del></del>	<del></del>					<b>*</b>	
_										<del> </del>		<u> </u>					<del></del>
					•												
	<del></del>				<del></del> -			<del> </del>	<del></del>	<del></del>		<del></del>			<del></del>		
												·					·
_																	
-			5	ENSITIV	LTY. ANA	LYSIS									<del></del>		
												_					
-		R	ATING F	OR EACH	CONCEP	T AFTER	INCREA	SING			<del></del>						
_		SINGLE	SELECTI	ON PARA	METER W	EIGHTIN	G FACTO	R BY 5	0 8		· .					·	
		•	(BAS	ED ON 1	AM & CO	X POINT	S }		•								
-					<del></del>	<u> </u>			<del></del>		<del></del>		<del></del>	<del> </del>	, ,		<del></del>
				na de la	CON	CEPT										<u> </u>	
_		1	2	3	4	5	6	7	8	9	10	1.1	12		<b>.</b>		
_				10.78					OF - 40	01.05	49.04	05.49	00.44				· · · · · · · · · · · · · · · · · · ·
	NORMAL	23 • 65	7 • 2 1	10.78	47.28	72.30	00017	71974	00.00	70 4 0 3	. 4 4 4 6	73407	0.417.	1			
_	WEIGHT	21 - 89	6.62	9.96	43.99	92.42	86.72	92.11	86.34	95.99	90.28	95 • 67	89.91				
	POWER	25.87_	6.62	12.26	50-11_	92.92	_87.23	92.59	_86•B4_	_96•37_	_ 90•68_	96.04_	_90•29_	· · · · · · · · · · · · · · · · · · ·			···
	VOLUME	22.81	7.29	10.18	46.99	90.71	81.95	90 - 20	81 • 34	95.91	87.15	95.39	86.54				
-	THERMAL	23 • 61	6+62_	11 • 09 <u>-</u> 10 • 47	45 • Zû _	92.92_ 92.52	87•23_ 86•59	92•59_ _92•17	_ 86•07_ _ 86•09	76•37_ 96•16	- 70•86 90•15	76 • U 7_ 95 • 82	89.74	·			
	MAINTENC	23.75	7.07	10 - 47	47.68	92.52	86.50	92-17	86 • 09	96.16	90 - 15	95 • 82	89.74				
-	SAFETY	24.40	7.00	11.90	48.79	92.52	86.50	92.17	86.09	96.16	90 • 15	95.82	89.74				$\Box$
<u>:</u>	DEV_COST	22.181_	9.32	9 9 9 0	47.77	91.84	86.15	91.51	85.76	95 • 29	<u>89•60</u>	94.96	89.21	<del></del>	·		<i>V</i> >
					•									•			
_		National			•	<del></del>				<u> </u>						<del>-,</del>	<u> </u>
-														•			-11356
-											·				•		O ₁
-				ENSITIV													<u> </u>
-			s	ENSITIV	1-TY ANA	LYSIS_									6		<u> </u>
-			S ATING F	ENSITIV	JTY ANA	LYSIS_	INCREA	SING			•				•		<u> </u>
-		SINGLE	S ATING F SELECTI	ENSITIV	ITY ANA CONCEP METER W	LYSIS_ T AFTER	INCREA G_FACTO	SING						-		<b>1</b>	<u> </u>
-		SINGLE	S ATING F SELECTI	ENSITIV	ITY ANA CONCEP METER W	LYSIS_ T AFTER	INCREA G_FACTO	SING							OF.		<u> </u>
-		SINGLE	S ATING F SELECTI	ENSITIV	ITY ANA CONCEP METER W	LYSIS_ T AFTER	INCREA G_FACTO	SING								<del></del>	<u> </u>
-		SINGLE	SELECTI (BAS	OR EACH ON PARA ED ON 1	CONCEPMETER W	LYSIS_ T AFTER	INCREA G FACTO	SING R BY -5	C \$							<del></del>	<u> </u>
-		SINGLE	S ATING F SELECTI	ENSITIV	CONCEPMETER W	T AFTER	INCREA G FACTO	SING				11	12		Poor	ALIANI.	<u> </u>
	NORMAL	SINGLE	STING F SELECTI (BAS	OR EACH ON PARA ED ON 1	CONCEPMETER WOOD 8 MA	T AFTER EIGHTIN X POINT C E P T	INCREA G FACTO 5)	SING R BY -5	O \$		10		12		Poor o	A LI LI	<u> </u>
	NORMAL	\$ INGLE	SELECTI (BAS	OR EACH ON PARA ED ON 1	CONCEPMETER WOO & MA	T AFTER EIGHTIN X POINT C E P T 5	INCREA G FACTO S)	SING R BY -5	0 \$ 8 85•68	9 76.05	1C 89.86	11 75 • 69	12		Poor o	A LI LI	<u> </u>
	WEIGHT	1 23.65	ATING F SELECTI (BAS	OR EACH ON PARA ED ON 1	CONCEPMETER WOO & MA	T AFTER EIGHTIN X POINT C E P T 5 92.30	INCREA G FACTO S) 6 86.10	SING R BY -5	0 \$ 8 85.68	9 ?6.05	1C 89.86	11 95•69	12 89.44 88.87		Poor o	A LI LI	<u> </u>
	WEIGHT POWER	1 23.65 25.75 21.00	7.90	OR EACH ON PARA ED ON 1	CONCEPMETER WOO & MA	T AFTER EIGHTIN X POINT C E P T 5 92.30 92.15 91.55	INCREA G FACTO 5) 6 86.10 85.37 84.76 90.77	5ING R BY -5 7 91.94 91.74 91.16	8 85.68 84.90 84.30 90.57	9 ?6.05 96.12 95.67 96.21	1C 89.86 89.35 88.87 92.90	11 95.69 95.72 95.28 96.03	12 89.44 88.87 88.42 92.70		Poor o	A LI LI	<u> </u>
	WEIGHT	1 23.65	7.90 7.90 7.12	OR EACH ON PARA ED ON 1 3 10.78	CONCEPMETER WOOD & MA  CON N 4 47.28 51.20 43.90 47.60 49.75	T AFTER EIGHTIN X POINT 5 92.30 92.15 91.55 94.08 91.55	INCREA G FACTO 5) 6 86.10 85.37 84.76 90.77	51NG R BY -5 7 91.94 91.74 91.16 93.90 91.16	8 85.68 84.90 90.57 64.30	9 76.05 96.12 95.67 96.21 95.67	89.86 89.35 88.87 92.90 88.87	11 75.69 75.72 95.28 96.03 95.28	89.44 88.87 88.42 92.70 88.42		Poor	A LI LI	<u> </u>
	WEIGHT POWER VOLUME THERMAL RELIAB-Y	1 23.65 25.75 21.00 24.58 23.69 23.18	7 • 90 7 • 90 7 • 90 7 • 12 7 • 90 7 • 12	OR EACH ON PARA ED ON 1 10.78 11.75 9.01 11.45 10.41	CONCEPMETER WOOD 8 MA  CON N 4  47.28  51.20 43.90 47.60 49.75	T AFTER EIGHTIN X POINT  5 92.30 92.15 91.55 94.08 91.55	INCREA G FACTO 5) 6 86.10 85.37 84.76 90.77 84.76	SING R BY -5 7 91.94 91.16 93.90 91.16 91.70	8 85.68 84.90 90.57 84.30 85.25	9 76.05 96.12 95.67 95.67 95.93	1C 89.86 89.35 89.87 72.90 88.87 89.55	11 75.69 75.72 95.28 96.03 95.28 95.56	12 89.44 88.87 88.42 92.70 88.42 89.12		Poor o	A LI LI	<u> </u>
	WEIGHT POWER VOLUME THERMAL RELIAB-Y MAINTENC	23.65 25.75 21.00 24.58 23.69 23.18 23.54	7.21 7.90 7.90 7.12 7.90 7.34	OR EACH ON PARA ED ON 1 10.78 11.75 9.01 11.45 10.41 11.10	CONCEPMETER WOO 8 MA  CON 14  47.28  51.20 43.90 47.60 49.75 46.70 46.85	T AFTER EIGHTIN X POINT 5 92.30 92.15 91.55 94.08 91.55 92.06	INCREA G FACTO 5) 6 86.10 85.37 84.76 90.77 84.76 85.68	SING R BY -5 7 91.74 91.16 93.16 91.16 91.70	8 85.68 84.90 90.57 84.30 90.57 85.25 85.25	9 76.05 96.12 95.67 95.67 95.67 95.67	1C 89.86 89.35 88.87 72.90 88.87 89.55	95.69 95.72 95.73 96.03 95.28 95.56 95.56	12 89.44 88.87 88.42 92.70 88.42 89.12		Poor o	A LI LI	<u> </u>
	WEIGHT POWER VOLUME THERMAL RELIAB-Y MAINTENC SAFETY	23.65 25.75 21.00 24.58 23.69 23.18 23.54 22.85	7.90 7.90 7.90 7.90 7.12 7.90 7.34 7.35	OR EACH ON PARA ED ON 1 10.78 11.75 9.01 11.45 10.41 11.10 9.59	CONCEPMETER WOO 8 MA  CON 8 MA  CON 9 MA  47.28  51.20 43.90 47.60 49.75 46.70 46.85	T AFTER EIGHTIN X POINT 5 92.30 92.15 91.55 94.08 91.55 92.06 92.06	INCREA G FACTO 5) 6 86.10 85.37 84.76 90.77 84.76 85.68 85.68	SING R BY -5 7 91.74 91.16 93.90 91.70 91.70 91.70	8 85.68 84.70 84.30 90.57 84.30 85.25 85.25	9 76.05 96.12 95.67 95.67 95.67 95.93 95.93	89.86 89.35 88.87 92.90 88.87 89.55 89.55	95.69 95.72 95.28 96.03 95.28 95.56 95.56	89.44 88.87 88.42 97.70 88.42 89.12 89.12		Poor o	A LI LI	<u> </u>
	WEIGHT POWER VOLUME THERMAL RELIAB-Y MAINTENC	23.65 25.75 21.00 24.58 23.69 23.18 23.54	7.90 7.90 7.90 7.90 7.12 7.90 7.34 7.35	OR EACH ON PARA ED ON 1 10.78 11.75 9.01 11.45 10.41 11.10	CONCEPMETER WOO 8 MA  CON 8 MA  CON 9 MA  47.28  51.20 43.90 47.60 49.75 46.70 46.85	T AFTER EIGHTIN X POINT 5 92.30 92.15 91.55 94.08 91.55 92.06 92.06	INCREA G FACTO 5) 6 86.10 85.37 84.76 90.77 84.76 85.68 85.68	SING R BY -5 7 91.74 91.16 93.90 91.70 91.70 91.70	8 85.68 84.70 84.30 90.57 84.30 85.25 85.25	9 76.05 96.12 95.67 95.67 95.67 95.93 95.93	89.86 89.35 88.87 92.90 88.87 89.55 89.55	95.69 95.72 95.28 96.03 95.28 95.56 95.56	89.44 88.87 88.42 97.70 88.42 89.12 89.12		Poor o	A LI LI	<u> </u>
	WEIGHT POWER VOLUME THERMAL RELIAB-Y MAINTENC SAFETY	23.65 25.75 21.00 24.58 23.69 23.18 23.54 22.85	7.90 7.90 7.90 7.90 7.12 7.90 7.34 7.35	OR EACH ON PARA ED ON 1 10.78 11.75 9.01 11.45 10.41 11.10 9.59	CONCEPMETER WOO 8 MA  CON 8 MA  CON 9 MA  47.28  51.20 43.90 47.60 49.75 46.70 46.85	T AFTER EIGHTIN X POINT 5 92.30 92.15 91.55 94.08 91.55 92.06 92.06	INCREA G FACTO 5) 6 86.10 85.37 84.76 90.77 84.76 85.68 85.68	SING R BY -5 7 91.74 91.16 93.90 91.70 91.70 91.70	8 85.68 84.70 84.30 90.57 84.30 85.25 85.25	9 76.05 96.12 95.67 95.67 95.67 95.93 95.93	89.86 89.35 88.87 92.90 88.87 89.55 89.55	95.69 95.72 95.28 96.03 95.28 95.56 95.56	89.44 88.87 88.42 97.70 88.42 89.12 89.12		Poor o	A LI LI	<u> </u>

APPLIANCE FUNCTION: 1.3.2-DISHWASHER/DRYER COMBINATIONS WITH DISPOSABLES (PAGE 1 OF 2)

			4	N U	J M B	E R	0	F	<b>C</b> 0	M P C	N E	NTS	}			· Poorgons	
COMPONENT TYPE	<b>О</b> моток	фМЛ	© VALVE	ACCUMULATOR	ATER EPARATOR	TRANSMISSION (GEAR BOX)	FILTER	HEAT EXCHANGER	CONTROLLER TIMER	BLOWER AIR	HEATER OC	DESICCANT CANISTER		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			NUMBER OF SAFETY CRITICAL
APPLIANCE TYPE NO.	1	0	3	4	(E)	<b>7</b>	9	(B)	ت آ	(B)	0	<u>a</u>	0	0	0	0	ITEMS
HOT WATER SPRAY-CENTRIFUGE DRYING	2	1	2	2	1	1	1		1	-	-	-	•				1
HOT WATER SPRAY WASH-FORCED HOT AIR ELECTRIC HEAT DRYING (pg. 102)	-2	1	2	2	1	1	1	1	1	1	1	-	i 		•		2
HOT WATER SPRAY WASH-FORCED COLD AIR-DESICCANT-ELECTRICALLY HEATED (pg. 104)	2	1	3	2	1	1	1	1	1	1	1	1					1
MANUAL WASH-MANUAL WIPE	1	1	2	1	-	-	-		-	-	-	-					0 -
DISPOSABLE CUPS REUSABLE METALLIC KNIVES, FORKS, SPOONS REUSABLE METALLIC DISHES	-	•	-	-	- 12	•	• • •	<b>-</b>	•	-	•	-				·	0
DISPOSABLE CUPS REUSABLE METALLIC KNIVES, FORKS, SPOONS DISPOSABLE NONMETALLIC DISHES	<b>-</b>	•	-	<u>-</u>	-	_	<b>-</b>	-	-	<b>-</b>	-	-			•		0
DISPOSABLE CUPS DISPOSABLE NONMETALLIC KNIVES, FORKS, SPOONS REUSABLE METALLIC DISHES	•	<b>.</b>	-	-	-	-	-		•	•	<b>. =</b> ,	- - - -					0
DISPOSABLE CUPS DISPOSABLE NONMETALLIC KNIVES, FORKS, SPOONS DISPOSABLE NONMETALLIC DISHES	<b></b>	•	-			-	- ·	-	-	-	-	- -					0
			•			•											

APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 1.3.2-DISHWASHER/DRYER COMBINATIONS WITH DISPOSABLES (CONCLUDED) (PAGE 2 OF 2)

				Νŧ	J M B	E R	0	F	C O	мРС	) N E	NTS	;				. i•
APPLIANCE TYPE NO.	(E) MOTOR	⊘ PUM <b>P</b>	© VALVE	⊕ ACCUMULATOR		TRANSMISSION (GEAR BOX)	© FILTER	HEAT EXCHANGER	© CONTROLLER TIMER	BLOWER AIR	(Z) HEATER DC	© DESICCANT CANISTER					NUMBER OF SAFETY CRITICAL ITEMS
REUSABLE CUPS REUSABLE METALLIC KNIVES, FORKS, SPOONS REUSABLE METALLIC DISHES	-	-	-	-	-	•	<u>.</u>	-	-	-	-	-	<u>U</u>	J	U	U	0
REUSABLE CUPS REUSABLE METALLIC KNIVES, FORKS, SPOONS DISPOSABLE NONMETALLIC DISHES	_	-	•	_	-	-	-	-	<b>.</b>	-	-	-					0
REUSABLE CUPS DISPOSABLE NONMETALLIC KNIVES, FORKS, SPOONS REUSABLE NONMETALLIC DISHES		-	<b>-</b>	-	-	_	-		-	-	-						0
REUSABLE CUPS DISPOSABLE NONMETALLIC KNIVES, FORKS, SPOONS DISPOSABLE NONMETALLIC DISHES	•		-	-	_	-	•	* <b>-</b>	-	•	-	. <b>-</b>					0
															:		•
										•							•

SPACECRAF.	T Shuttle					
HABITABIL	Food ITY SUBSYSTEM Manag	ement	HABITABILITY	FUNCTION	Galley C	leanup
APPLIANCE	FUNCTION Dishwash	er/Dryer wit	n Dishes .	•		·
APPLIANCE	CONCEPT NO./TITLE_	1/Hot Water	Spray-Centri	ifuge Dryi	ng	
INDEX NO.	1.3.2.1		REF. NO	90		
					and the second	

#### DESCRIPTION

This is the same concept presented in Section 1.3.1.1. It is included here to compare with the case where no dishwasher/dryer is used and dishes are either disposable or hand-wiped clean.

CONCEPT Hot water	APPLI Spray.	ance concept requi	REMENTS AND PENALTI . drying	ES CALCULATIONS INDEX	NUMBER 1. 3.2.1
					• • • •
	ELEC			UIREMENIS	
	(1)	· A C		(4) MAND (5)	POWER
	USE TIME CYCLE	② PEAK	AVEDACE (WAT	T-HR/ DEAV	6 DEMAND  AVERAGE (WATT-HR
COMPONENT (REF)	(HR)	(WATTS)	LIL	X③ (WATTS)	(WATTS) CYCLE)
Motor.					
Valves	0				
Pump					
				<del></del>	
		_			
		100	·	50	
	•••	MAXIMUM	TO	TAL MAXIMUM	TOTAL
	•				
	i •		•		
		•			
		IHERMAL	REQUIREME	NIS	
***************************************					
counce		LATENT (BTU/HR)	SENSTBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
SOURCE		(Broynk)	(DIO/IIA)	(0,0,1,1,0,1	, <b>, , , , , , , , , , , , , , , , , , </b>
Water heat loss	(40°F)				_ • • •
Pump					
Motor-					
Water (drying)	)	· · · · · · · · · · · · · · · · · · ·			
	<u> </u>				
		62 (212)	248 (845	<u> 248 (845</u>	5) 0
	TOTAL	WATT (BTU/HR)	WATT (BTU/HR		
		war (broying)	WALL (DIO) III	iy imari (bioyua)	· MAIT (DIO)III)
		005047101		TICC	
		<u>OPERATION</u>	LAL PENAL		
	HE	THERMAL AT LEAK TO	COOLANT ELE	ECTRICAL WEIGH	
SOURCE	(BTU/	HR/CYCLE) (BTL	COOLANT ELE I/HR/CYCLE) (PK I	WATTS/CYCLE) (LB/MISS	ION) (FT3/MISSION)
N/A			ting seat of disease. National to be asset to		
	<del></del>				
	<del></del>				<del>Anglia de la Calenda de la</del> Calenda de la Calenda de la
	TOTAL				

WATTS/CYCLE (BTU/HR/CYCLE)

WATTS/CYCLE (BTU/HR/CYCLE) M3/MISSION (FT3/MISSION)

KG/MISSION (LB/MISSION)

	<u>F 1 X</u>	ED WELGH.I/	VOLUME REQ	UIREMENIS	
COMPONENT	•	(REF)	WEIGHT (LBS)	•	VOLUME (FT3)
· Basic wa	sher /dry				
Pump	1 1		•		
2 Accum Velvina	MATORS	· · · · · · · · · · · · · · · · · · ·			
Water se	parador				
Packaging Dishes/	tinsels/cu	<u></u>		<del></del>	
Total	CIII Z Z Z Z Z	<i></i>			
				· · · · · · · · · · · · · · · · · · ·	
		TOTAL	33.5 (74	.0) 0.	477 (16.
	•		KG (LBS)		M3 (FT3)
	<u> </u>	EXPENDABL	E WI/YOL	REQUIREMENTS	
					(5) VOL/CYCLE
TUAE	(I)		T)(REF) (1)X(2)	VOL/UNII (REF (PKG.VOL/UNII)(	) VOL/CYCLE REF) ① X ④ (FT³)
Detergent	/ UNITS/CYCI	LE(REF) (LB) • 010	(LB)	(FT ³ )	(FT1) .0003
germicia	Έ	(.012	.)	.00035	
#1 1 					•
			Σ3 .012 TOTAL WI/C	YCLE \(\sum_{\text{YCLE}}\)	(5) .0003.
	المناب والما		(LB)		(FT ³ )
TOTAL LIT	3	x 20.5	x	<u> </u>	$0.3 \ (0.7)$
TOTAL WT. #	CYCLES/DAY	DAYS/MISSION	(LB)		KG (LB)
		the contract of the contract o		= [0.00	063 (0.0)
TOTAL VOL MISSION =	3	x 20.5	x .00035	0.00	and the second second
	3 CYCLES/DAY	x 20.5  DAYS/MISSION	x .00035 101.VOL/CYCLI (FT ³ )		0.63 (0.02 Nº (FT³)
	CYCLES/DAY	x 20.5 DAYS/MISSION	TOT. VOL/CYCL	[ <i>0.00</i>	Nº (FT³)
	CYCLES/DAY  G A S/L 1	DAYS/MISSION	TOT.VOL/CYCLI (FT³)		Nº (FT3)
		DAYS/MISSION  LQUID EXPE	IOT.VOLZCYCLI (FT3)	E E Q U L R E M E N T S	
TOTAL VOL MISSION	<u>G A S/L 1</u>	DAYS/MISSION  LQULD EXPE  O  T.USED/CYCLE(REF)	NDABLES RI	E E Q U L R E M E N T S	
TYPE	<u>G A S/L 1</u>	DAYS/MISSION  LQUID EXPE	NDABLES R S  RECOVERY  FACTOR	EQUIREMENIS  AMT.RECOVERED/CYCLE  () () () () () () () () () () () () ()	M ³ (FT ³ )  AMT LOST/CYC ① - ③ (LB) 10.
TOTAL VOL MISSION	<u>g a s/l</u> ! a	DAYS/MISSION  LQUID EXPE  O  T.USED/CYCLE(REF) (LB)	NDABLES RI	EQUIREMENIS	AMT LOST/CYC ①-③ (LB)
TYPE	<u>GAS/L</u> Al	DAYS/MISSION  I Q U I D E X P E  O  MT.USED/CYCLE (REF). (LB) 1D •	NDABLES RECOVERY	EQUIREMENIS  AMT.RECOVERED/CYCLE  () () () () () () () () () () () () ()	AMT LOST/CYC ① - ③ (LB)
TYPE	<u>GAS/L</u> Al	DAYS/MISSION  LQUID EXPE  OT.USED/CYCLE(REF) (LB) 1D - 10	NDABLES RECOVERY	EQUIREMENIS  AMT.RECOVERED/CYCLE  () () () () () () () () () () () () ()	AMT LOST/CYC ① - ③ (LB)
TYPE	<u>GAS/L</u> Al	DAYS/MISSION  LQUID EXPE  T.USED/CYCLE(REF) (LB) 1D 10	NDABLES RECOVERY	EQUIREMENIS  AMT.RECOVERED/CYCLE  () () () () () () () () () () () () ()	AMT LOST/CYC ① - ③ (LB) 10.

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SPACECRATT	Shuttle	a Maran Gardinia in trade and annual and development and annual and annual and annual	• • • • • • • • • • • • • • • • • • •			
IINBITABILII	Y SUBSYSTEM Food	Management	JIABITABILIT	Y FUNCTION Ga	lley Clean	up
APPLIANCE I	UNCTION Dishwas	her/Dryer wi	th Dishes		in a second and the second	
VENTURE (	CONCEPT NO./TITLE	2/Hot Water	Spray - For	ced Hot Air []	ectric Hea	t <u>Dr</u> ying
INDEX NO	1.3.2.2		REF. NO.	90		
here to co	: This is the s	se where no	presented in dishwasher/d	Section 1.3.1 ryer is used a	.3. It is and dishes	included are

concept Hot water	heat dire	- forced h	ot an	*Houn (	NUMBER 1.3.	
, electric	heat dry ELECIBLES	L POWER	REQUIRE	MENTS		•
•		AC , POWI	R (4)	<u>D C</u>	POWER	
	CYCLE . PE		DEMÁND (WATT-HR/ CYCLE)	(5) PEAK	MERMOL	DEMAND (WATT-HR CYCLE)
COMPONENT (REF)	(HR) (WAT		①×③	(WATTS)	(WATTS)	①x①
Fan Motor Hecter						
Pump						
	— 1 MAXI	<del></del>	TOTAL	217 MAXIMUM	•	TOTAL
	IHER	MAL REQUI	REMENTS			
SOURCE	LATE (BTU/		ISIBLE IU/HR)	HEAT LEAK (BTU/HR)	TO COO	
Pump Water heat loss						
Fan Motor					<u>.</u>	
Herter Water (drying)	<u> </u>		•		•	
	TOTAL 62. (2) WATT (B		(BTU/HR)	248 (845 WATT (BTU/HR)	.) <u>165 (</u>	
		<u>TIONAL</u> P.	ENALIIES			
SOURCE	HEAT LEAK (BTU/HR/CYCLE)	TO COOLANT (BTU/HR/CYCLE)	PK WATTS/CYC	WEIGHT CLE) (LB/MISSI		ISSION)
N/A						

B2-110

WATTS/CYCLE (BTU/HR/CYCLE)

WATTS/CYCLE (BTU/HR/CYCLE) KG/MISSION)

M3/MISSION (FT3/MISSION)

	EIXE	D WEIGHT	<u> VOLUME REQ</u>	UIREMENIS	
COMPONENT		(REF)	WEIGHT (LBS)		VOLUME (FT3)
Basic h	vasher Aryer	<u></u>			
Pump 2 Accu	ny lators				
Velving			i apin di apinggan panggan panggan panggan di apinggan panggan panggan panggan panggan panggan panggan panggan Panggan panggan pangga		
Water so	eparalor		•		
Pockagin	.0				
Dishes/	ritinsols / cu	<u>ps                                     </u>			
Toles			<del></del>		and and and analysis of the same of the sa
		TOTAL	39.9 (88)		7.7 (16.
	•	•	KG (LBS)		Nº (FT3)
	<u>s o l I o</u>	EXPENDAB	<u>-</u>	REQUIREMENT	<u>. s</u>
		WT/UNIT (PKG.WT/UN (REF) (LB	(REF) WT/CYCLI	E VOL/UNIT (PKG.VOL/UNIT (FT ³ )	(SEF) VOL/CY
ТҮРЕ	UNITS/CYCLE	(REF) (PKG.WIYUN	it)(REF) ①X② ) (LB)	(PKG. VOL/UNI (FT ³ )	r)(REF) () X ( FT ³
Deterge	<del>-1/,</del>	<del></del>			
germi	cide				
	<del></del>				
				<del></del>	
					<del></del>
			TOTAL WIZE	ÝCLE	Σ ^⑤ TOTAL VOL
TOTAL UT			(LB)		(FT ³
MISSION -	CYCLES/DAY X	DAYS/MISSION	X TOT.WI/CYCLE		0.3 (0.7 KG (LB)
TATA: 1/A:	O) OLLOY DATE		(LB)		
MISSION -	CYCLES/DAY X	DAYS/MISSION	XX	<u> </u>	00063 (0.
e National design	CICCESTOAT	DATSTER	TOT. VOL/CYCLI		
	G A S/L I C	Q <u>U I D</u> <u>E X P</u> !		EQUIREMENT:	
		Ф	RECOVERY	AMT. RECOVERED/CYC	E AMT LOST
TY	PE AMT.	.USED/CYCLE(REF) (LB)	FACTOR	(rB)	E AMT LOST/ 1)-(3 (LB)
	uater		<del></del>		
Kinse	valet				
<del></del>			•		
	Σ0 _			$\Sigma$	<b>①</b>

SPACECRALT Shu	ttle	alana Madistripa (1979) (1984)			
HABITABILITY SUBS	YSTEM Food Managem	ent_HABITABILITY I	FUNCTION Galley	Cleanup	
APPLIANCE FUNCTIO	N Dishwasher/Drye	r with Dishes	4		
APPLIANCE CONCEPT	NO./TITLE 3/Hot W	ater Spray - Forced	Air/Desiccant/	' <u>Desorbed Elect</u>	ric
INDEX NO.	1.3.2.3	REF. NO.	90 .		•
here to compare	is is the same conc with the case where e or hand-wiped cle	no dishwasher/drye	ction 1.3.1.4. r is used and d	It is included lishes are	đ

• •					<b></b>	• • •	•
	ELEC	•	OWER	REQUIR	E <u>MENTS</u> DC	POWE	/ D
· · · · · · · · · · · · · · · · · · ·	USE TIME	②	<u>, powe</u>	DEMAND (WATT-HR/	<u> </u>	6	DEMAND (WATT-HR CYCLE) (DX()
	CYCLE	PEAK	AVERAGE	CYCLE)  ① X ③		AVERAGE (WATTS)	CYCLE)
OMPONENT (REF)	(HR)	(WATTS)	(WATTS)	₩. •	(W/(13)	(WALLS)	Ψ^ <i>Φ</i>
Fan					*		
Valves			· · · · · · · · · · · · · · · · · · ·		·	<del></del>	
Heater							<u></u>
Пертел		• • • • • • • • • • • • • • • • • • •					
		_		<del></del>			
•		-					
·		116	•,		97	•	
		MAXIMUM	•	TOTAL	MAXIMUM		TOTAL
			•				
r• Partition of the state of t							
		•	. • •				
	•	THERMAL	REQUI	REMENTS			
	•	LATENT	SEN	SIBLE	HEAT LEAK		COOLANT
SOURCE		(BTU/HR)	(BT	U/HR)	(BTU/HR)	(	BTU/HR)
Water heat loss	(400E)	•		•			•
	LUP P				*		
Prmp Motor							
Fan				<del></del>	· · · · · · · · · · · · · · · · · · ·		
Heater	<del></del>						•
. Water (drying)				/ \			- (
	TOTAL	62 (212)		(839)	246 (839)		(221
		WATT (BTU/HR)	WATT	(BTU/HR)	WATT. (BTU/HR)	.WAT	T (BTU/HR)
			• •				
	na editirii ja Kalendari						
				- 4 4 1 7 7 6			
		<u>OPERATION</u>	AL L	ENALTIE			
	HE	THERMAL TO	COOLANT	ELECTRICA			VOLUME
SOURCE	(BTU/I	IR/CYCLE) (BTU	/HR/CYCLE)	(PK WATTS/	CYCLE) (LB/MISSIO	N) (FT	3/MISSION
N/A							
	<del>الفضاة</del> . <del>سيجيم</del>	•					
	<del></del>						•
	OTAL	그리고 있는 얼마나다					and the second second second

(1)

concept Hot water spray wash - Forced cold air desiccant. INDEX NUMBER 1.3.2.3 FIXED HEIGHT/VOLUME REQUIREMENTS VOLUME (FT³) COMPONENT (REF) Bosic washer/dryer Pump Volvino Desigrand Packaging Dishes / utinsels/cups TOTAL .525 37.5 KG (LBS) M3 (FT3) SOLID H I/Y O L EXPENDABLE REQUIREMENIS VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³) ₩Ţ/CYCLE WT/UNIT (REF)
(PKG.WT/UNIT)(REF)
(LB) ① X ② (LB) UNITS/CYCLE(REF) Detergent/ Germicide  $\Sigma \overline{ { \mathfrak G}}$  $\Sigma$   ${}_{f \odot}$ TOTAL WT/CYCLE (LB) TOTAL VOL/CYCLE (FT3) TOTAL WT. TOT.WT/CYCLE (LB) CYCLES/DAY DAYS/MISSION KG (LB) MISSION . 0.00063(0.02 M3 (FT3) CYCLES/DAY GAS/LIQUID EXPENDABLES REQUIREMENTS 0 AMT.RECOVERED/CYCLE AMT LOST/CYCLE RECOVERY AMT. USED/CYCLE (REF)
(LB) ① X ② (LB) **FACTOR**  $\Sigma$  (4)  $\Sigma$  0 MISSION . TOTAL TOST/CYCLE (Z (D)

(LB)

(z (I)

SPACECRAFT	Shuttle	, ·	. •		
HABITABILITY	SUBSYSTEM Food Mana	gement MABITABILIT	Y FUNCTION	Galley Cleanup	)
APPLIANCE FU	NCTION Dishwasher/D	ryer with Dishes			- 
APPLIANCE CO	NCEPT NO./TITLE 4/Ma	nual Wash - Manual W	lipe Dry		
INDEX NO.	1.3.2.4	REF. NO.	90		
DESCRIPTION	: This is the same c	oncept presented in	Section 1	3.1.10. It is	a

DESCRIPTION: This is the same concept presented in Section 1.3.1.10. It is a dishwasher concept which is manually operated by a crewman. It is included here to compare with the case where no dishwasher/dryer is used and dishes are either disposable or hand-wiped clean with wet and dry wipes.

		OTCA!	<b> </b>	UIREMENTS	•
	<u> </u>	<u>RICAL P</u>	OWER REQ		C POWER_
component (REF) Towel Pryer	USE TIME CYCLE (HR)	② PEAK (WATTS)	③ DE AVERAGE (WAT	MAND (5)	(MATTS)
		14.7		`	
		MAXIMUM	TO	TAL MAXIMUM	TOTAL
		THERMAL	REQUIREME		TO COOL AND
SOURCE	• 1	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAN (BTU/HR)	( TO COOLANT (BTU/HR)
Water heat los	s (40°F)				
Towel dryer					
	TOTAL	WATT (BTU/HR)	MATT (BTU/HR	235 (80 ) WATT (BTU/	
	TOTAL	WATT (BTU/HR)	WATT (BTU/HR	WATT (BTU/)	
	TOTAL	OPERATION THERMAL	MATT (BTU/HR  A L PENAL  COOLANT ELE	WATT (BTU/)	IR) WATT (BTU/HR)  GHT VOLUME
Towel dryer	TOTAL	OPERATION THERMAL TO LEAK	MATT (BTU/HR  A L PENAL  COOLANT ELE	LLES	IR) WATT (BTU/HR)  GHT VOLUME

WATTS/CYCLE (BTU/HR/CYCLE)

WATTS/CYCLE (BTU/HR/CYCLE) M³/MISSION (FT³/MISSION)

KG/MISSION (LB/MISSION)

concept Manual wash - Manual wipe dry index number 1.3.2.4

MPONENT Basic Wa	sher	(REF)	•	WEIGHT (LBS)			VOLUME (FT)
Towel dry						1	
	sc/s/cups						
	<u></u>	+			•		
			·	· · · · · · · · · · · · · · · · · · ·			
					<del></del> ;		
				•			
ing the transfer of the second secon					-7-1	<u></u>	
	•	TOTAL	17.	<u>9 (39.</u>	3)	0.31	(10.7)
	<b>Q.</b>			KG (LBS) ,		- _{1.4} % • •	13 (FT3)
•	50110		A O I E I	1 T/V A 1		enénte	
	Z O L I D	EXPEND		(1)	REQUIR	<u>(a)</u>	ര
•	0	WT/U	(REF) T/UNIT)(REF) (LB)	MT/CYCL ①x② (LB)	E VO	(REF) .VOL/UNIT (REF) (FT ³ )	VOL/CYCLE
TYPE	UNITS/CYCLE(	REF)	(LB)	(î.8)	(1700	(FT ³ )	(L13)
Detergent/	•		<del></del>				
germicide							<u> </u>
				•			
			· · · · · · · · · · · · · · · · · · ·		<del></del>		*
			$\Sigma$ $\mathfrak{I}$	)		$\sum \overline{\mathbb{S}}$	
	• • • • • • • • • • • • • • • • • • •			TOTAL WI/C			TOTAL YOL/CYCLE (FT)
TAL WT.				, , ,			
CYC	LES/DAY X	DAYS/MISS	10N X —	TOT.WT/CYCLE		0.3	( 0.7)
				(LB)	•		
TAL VOL	<b>x</b>		x		•	0.0000	3(0.02)
CYC	CLES/DAY .	DAYS/MISS	ION	TOT. VOL/CYCL (FT3)	<b>E</b>		12 (513)
	i en grinden de						
							er i de la companya di dia di dia di dia di
	GAS/LIG	I <u>UID</u> E	X P E N D A !		EQUIRE		
		0		<b>②</b> RECOVERY	AMT. RECOV	③ YERED/CYCLE X② LB)	ANT LOST CYCLE
TYPE	AMT.	USED/CYCLE(RE (LB)	F)	FACTOR	0	XQ LB)	①-③ (LB)
	er	(0)	•		•	,507	(20)
Rinse water							
_				<del> </del>			<u> </u>
		<del></del>			<u> </u>		<del></del>
	<del></del>			<u> </u>			•
	<u> </u>	<del> </del>			• • • • • • • • • • • • • • • • • • • •	~~~	
	$\Sigma \odot$ —			•	\$7 M.T.	Σ@ _	<del></del>
TAL WT.							200 (125)
188100	70AY XX	YSZMISSTON	* . 1017[-1.05]	1	•	•	288 (635) KG (LB)

SPACECRAFT	Shuttle	·			1° 7
<b>HABIT</b> ABILI	TY SUBSYSTEM	Food Management	HABITABILIT	Y FUNCTION	Galley Cleanup
APPLIANCE	FUNCTION	Dishwasher/Drye	r with Dishes		en e
<b>APPLIANCE</b>	CONCEPT NO./	TITLE 5 through	12/Disposable	-Reusable	Dishes
INDEX NO	1.3.2.5	through 1.3.2.12	REF. NO. 10	0, 174, 17	7, 250, 276
		•			

#### DESCRIPTION

A detailed study was made of the food utensils, trays, and cups to determine the optimum selection from among a wide variety of possible combinations. The possible choices considered in each case are explained in the following paragraphs.

#### **CUPS**

<u>Disposable nonmetallic</u>. This is a prefilled collapsible plastic bellows type of cup used on Skylab. The cup is disposed of after use. Data for this case were taken directly from the Skylab cups (Reference 250). The number of cups used was based on the initial Skylab launch value of 1610 cups for 420 planned man-days.

Reusable metallic. This method of drinking resembles drinking from a cup with a straw as on Earth. It was tried on Skylab and was found to be quite satisfactory if the right size of straw is used. Data for this case were taken from Reference 276. It was assumed each man had two cups. One wet and one dry wipe were assumed to be used for each cup use, with the number of cup uses the same as for the disposable nonmetallic case.

#### UTENSILS - KNIFE/FORK/SPOON

Disposable metallic. This case was included for comparison purposes, although it resulted in a high penalty. Utensil weight and volume for stainless steel utensils, as on Skylab, were taken from Reference 250 and 177. It was assumed one knife/fork/spoon set per man for each meal was used, with no spares.

Reusable metallic. The same utensits as in the above case were assumed, with one wet wipe per man per meal allowed for cleaning as on Skylab. Since Skylab had three extra utensil sets (Reference 250) for a three-man crew, it was assumed one extra set was allowed per man.

<u>Disposable nonmetallic.</u> Data for this case were taken from References 174 and 177, with a 10 percent packaging factor included. One set per man per meal was assumed.

#### SERVING TRAYS

Two basic types of trays were considered: (1) ordinary dish type and (2) food warming trays. It was assumed the dish type of tray would be used with bulk food packaging, while the warming trays would be used with individual food cans.

APPLIANCE CONCEPT NO./TITLE 5 through 12/Disposable-Reusable Dishes (Continued)

#### DESCRIPTION

For direct comparison, a food packaging penalty was added to the warming trays to account for the individual food cans. These penalties were taken from Reference 276 for the food mix assumed in this study shown previously for the Food Habitability System 2.0. The resulting penalties are shown in Table B2-3.

Reusable heating type. This concept assumed reusable metallic covers for a heating tray, with two wet wipes and one dry wipe allowed to clean the cover. Data for the covers were from Reference 177, and include a 1 0 percent packaging factor. The food packaging penalty described previously for individual cans was added to the total weight and volume for this case. Based on the Skylab use of five food trays for a three-man crew (Reference 250), it was assumed six heating tray covers allowed for Shuttle.

Reusable metallic dish. Data for the dishes in this case were identical (Reference 177) to the reusable heating tray covers discussed previously, except that bulk food is assumed here with no packaging penalty. Again, two wet wipes and one dry wipe were assumed to clean the dishes per man.

<u>Disposable metallic dish</u>. Weight and volume for this type of dish were assumed the same as for the two previous cases. One dish per man per meal was assumed, with no wipes. Bulk food packaging was assumed; thus, no packaging penalty was added.

<u>Disposable nonmetallic dish</u>. Data for this case are identical to those for the disposable metallic dishes above except for dish weight. Dish weight was estimated using the same ratio used previously for metallic and nonmetallic utensils.

The data for all the previous cases are tabulated in Table B2-4 for the Shuttle case. The best eight cases were chosen by inspection, as indicated in the table, and included in the trades. To compare the previous cases with a dishwasher/dryer concept, a set of reusable utensils/dishes/cups to be used with the washer was selected from the previous cases. The number, weight, and volume for these items are shown in Table B2-5. These penalties were added onto the basic washer/dryer penalties given in Section 1.3.1 for direct comparison in the trades. The four best dishwasher/dryer concepts from the trades of Section 1.3.1 were selected in this section to trade with the eight best disposable dishes cases.

TABLE B2-3
PENALTIES ASSOCIATED WITH VARIOUS TYPES OF DISPOSABLE DISHES CONCEPTS
FOR SHUTTLE FOUR-MAN CREW

DISPOS	ABLE DISHES - TYPE	NUMBER	PACKAGED WEIGHT kg (1b)	PACKAGED VOLUME cu m (cu ft)
	Disposable Nonmetallic VEHICLE PENALTY	314	(21.5) 9.8	(5.95) .169
CUPS	Reusable Metallic Wet Wipes Dry Wipes TOTAL VEHICLE PENALTY	8 314 314	(2.0) (5.84) (3.12) (11.0) 5.0	(.187) (.135) (.125) (.45) .00127
	Metallic Disposable Utensils VEHICLE PENALTY	246	(61.2) 27.8	(2.07) .0586
KNIVES/ FORKS/ SPOONS	Metallic Reusable Utensils Wet Wipes TOTAL VEHICLE PENALTY	6 246	(1.45) (4.58) (6.03) 2.74	(.055) (.106) (.161) .00456
	Disposable Nonmetallic Utensils VEHICLE PENALTY	246	(4.87) 2.21	(.81) .0229
	Reusable Heating-type Tray Covers Wet Wipes Dry Wipes Food Packaging Penalty TOTAL VEHICLE PENALTY	6 492 246	(5.58) (9.15) (2.44) (42.6) (59.77) 27.1	(.252) (.211) (.098) (4.01) (4.57) .129
TRAYS	Reusable Metallic Dish-type Tray Wet Wipes Dry Wipes TOTAL VEHICLE PENALTY	6 492 246	(5.58) (9.15) (2.44) (17.17) 7.79	(.252) (.211) (.098) (.561) .0159
	Disposable Metallic Dish-type Tray VEHICLE PENALTY	246	(230) 104	(10.3) .292
	Disposable Nonmetallic Dish-type Tray VEHICLE PENALTY	246	(18.2) 8.3	(10.3) .292

TABLE B2-4 VEHICLE PENALTIES FOR VARIOUS DISPOSABLE DISHES CONCEPTS ASSUMING NO DISHWASHER AVAILABLE

	DISPOSABLE DIS	HES (TYPE)		SHU	TLE		
CUPS	KNIVES, FORKS, SPOONS	· TRAYS	- WEI	G H T	V O L	U M E	CONCEPT . NUMBER
DISPOSABLE METALLIC  DISPOSABLE  REUSABLE METALLIC		REUSABLE HEATING TYPE REUSABLE METALLIC DISH DISPOSABLE METALLIC DISH DISPOSABLE NONMETALLIC DISH	142.5 99.9 312.7 100.9	64.6 45.3 141.8 45.8	12.6 8.6 18.3 18.3	.357 .244 .518	* * * * *
		REUSABLE HEATING TYPE REUSABLE METALLIC DISH DISPOSABLE METALLIC DISH DISPOSABLE NONMETALLIC DISH	87.3 44.7 257.5 45.7	39.6 20.3 116.8 20.7	10.7 6.7 16.4 15.4	.303 .190 .464 .464	1.3.2.5 * 1.3.2.6
	DISPOSABLE NONMETALLIC	REUSABLE HEATING TYPE REUSABLE METALLIC DISH DISPOSABLE METALLIC DISH DISPOSABLE NOHMETALLIC DISH	• 86.2 43.6 256.4 44.6	39.1 19.8 116.3 20.2	11.3 7.3 17.1 17.1	.320 .207 .484 .484	* 1.3.2.7 * 1.3.2.8
	DISPOSABLE METALLIC	REUSABLE HEATING TYPE REUSABLE METALLIC DISH DISPOSABLE METALLIC DISH DISPOSABLE NONMETALLIC DISH	132.0 89.4 302.2 90.4	59.9 40.6 137.1 41.0	7.1 3.1 12.8 12.8	.201 .088 .362 .362	* * *
REUSABLE METALLIC	REUSABLE METALLIC	REUSABLE HEATING TYPE REUSABLE METALLIC DISH DISPOSABLE METALLIC DISH DISPOSABLE NONMETALLIC DISH	76.8 34.2 247.0 35.2	34.8 15.5 112.0 16.0	5.2 1.2 10.9 10.9	.147 .034 .309 .309	* 1.3.2.9 * 1.3.2.10
	DISPOSABLE NONMETALLIC	REUSABLE HEATING TYPE REUSABLE METALLIC DISH DISPOSABLE METALLIC DISH DISPOSABLE NONMETALLIC DISH	75.7 33.1 245.9 34.1	34.3 15.0 111.5 15.5	5.8 1.8 11.6 11.6	.164 .051 .329 .329	* 1.3.2.11 * 1.3.2.12

^{*}These concepts were not pursued further due to large penalties.

TABLE B2-5
WEIGHT AND VOLUME OF DISHES/UTENSILS/CUPS TO BE USED
WITH AUTOMATIC DISHWASHER/DRYER FOR SHUTTLE FOUR-MAN CREW

	NUMBER	PACKAGED WEIGHT kg (1b)	PACKAGED VOLUME cu m (cu ft)
DISH/TRAY	6	2.53 (5.58)	0.0071 (0.25)
KNIVES/FORKS/SPOONS	6	0.66 (1.45)	0.00156 (0.055)
CUPS	8	0.9 (2.0)	0.00530 (0.187)
TOTAL VEHICLE PENALTY		4.10 (9.03)	0.014 (0.49)

### 2.0 Personal Hygiene

#### APPLIANCE FUNCTIONS CONSIDERED

- 2.1.1 Fecal Collection/Transfer
- 2.1.2 Urine Collection/Transfer
- 2.1.3 Vomitus Collection/Transfer
- 2.2.1 Whole Body Shower
- 2:2.2 Partial Body Washing
- 2.2.3 Partial Body Drying
- 2.3.1 Shaving
- 2.3.2 Hair Cutting
- 2.3.3 Nail Care
- 2.3.4 Dental

#### DESCRIPTION

The personal hygiene habitability subsystem provides for waste collection/ transfer, body cleansing, and personal grooming. The concepts selected for trade included consideration of the zero-gravity effect on liquid flow and containment, the elimination and/or control of contamination which is easily spread in a zero-gravity environment, and the disposal of waste products within the spacecraft in the absence of the normal terrestrial sewers/septic tanks. These requirements must be satisfied with maximum safety and minimum weight, volume, and use of consumables. Waste collection appliance functions accommodate all of the bodily waste functions. Both partial and whole body washing techniques were considered during the study. The remaining personal hygiene appliance functions presented are for such crewman functions as shaving and hair cutting. The appliance concepts were evaluated to be functionally adequate and acceptable to the crewmembers from both physiological and psychological aspects prior to including them as viable concepts.

The fecal and urine collection/transfer appliance functions were considered separately for the purposes of trade studies. The two functions would most probably be combined for a space vehicle because of the attendant reduction in weight, volume, power, and thermal.

HABITABILITY SUBSYSTEM	2.0	Personal Hygiene	····
HABITABILITY FUNCTION_	2.1	Waste Collection/Transfer	
APPLIANCE FUNCTION	2.1.1	Fecal Collection/Transfer	
NUMBER OF CONCEPTS CONS	SIDEREC	9	• • •

#### **ASSUMPTIONS**

- (1) The fecal collection/transfer concepts consider wet, dry, chemical, decomposition, and incineration methods for disposing of fecal waste.
- (2) The study assumed one defecation per day per man. The concept use time required per defecation is dependent on the concept type.
- (3) Filter weight and volume were included if a high replacement frequency is required. Periodic filter replacement was not included in the study.
- (4) Component power requirements were normalized to provide a fair comparison of all concepts. The power requirements were not based on the latest fecal collector designs. This was done because the various manufacturers were in process of a competitive proposal response for the Shuttle waste collection system and could not be contacted for additional information.
- (5) Overboard venting was not allowed with the exception of nonfilterable gases. Concepts were modified to satisfy this requirement by adding a vacuum pump to the concept.
- (6) Fecal collection concepts requiring a day for decomposition of wastes and cooldown were allocated at one per crewman. The remaining concepts were provisioned at one per vehicle.

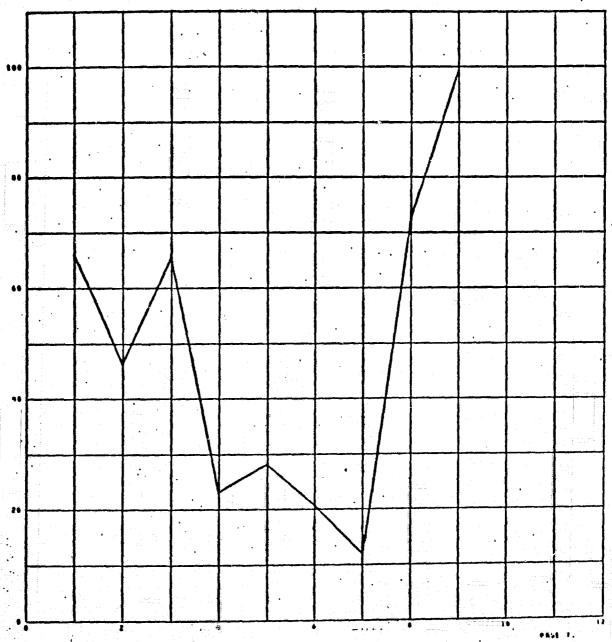
B2-125

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APPLIANCE
CONCEPT
NG. ...C.O.N.C.E.P.T. N.A.M.E.

I -- DRY JOHN
2 -- DRY JOHN-ANAL WASH
3 -- GERHICIDE
1 -- INTEGRATED VACUUM DECOMPOSITION
5 -- FLUSH FLOW OXYGEN INCINERATION
4 -- PYROLYSIS/BATCH INCINERATION
7 -- WET OXIDIZATION
8 -- SEMIAUTOMATIC BAG SYSTEM (SKYLAB)
9 -- DRY BAGS (APOLLO)



CONCEPT NUMBER

Fecal Collection/Transfer (Shuttle) Concept Trade

B2-129

# APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

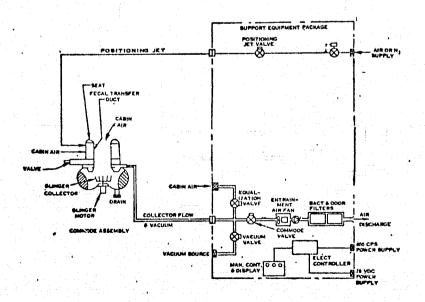
APPLIANCE FUNCTION: 2.1.1-FECAL COLLECTION/TRANSFER

			<del></del>	N U	МВ	ΕR	0	F	C O	мро	N E	NTS	<del></del>				
COMPONENT TYPE							~				OR.				· <u>·</u>		NUMBER
	VALVE SOLENOID	BLOWER	CHECK VALVES	PRESSURE REGULATOR	FILTER	PUMP	CONTROLLER TIMER	MANUAL VALVE	MOTOR	HEATER	ACCUMULATOR	•					OF SAFETY CRITICAL
APPLIANCE TYPE NO.	3 3	<b>図</b>	23 22	(II)	(F)	<u>a</u>	(19)	<u>₹</u> ≯	1	17	¥ (4)	0	0	O	0	0	ITEMS
. VACUUM DRY o NO ANAL WASH o NONVENTED	4	1	2	1	2	1	1	-	2	-	1	:					2
VACUUM DRY O ANAL WASH O NONVENTED	6	1	1	3	3	1	1	2	2	1	2		30				2
GERMICIDE o NO ANAL WASH	2	1	1	-	2	-	1	1	2	-	2						1
INTEGRATED VACUUM DECOMPOSITION O NO ANAL WASH	14	2	2	-	2	-	1	-	-	6	6			•			1
FLUSH FLOW OXYGEN INCINERATION O NO ANAL WASH	21	· 2	2	- '	2	-	1	<b>-</b> .	-	6	6						1
PYROLYSIS/BATCH INCINERATION O NO ANAL WASH	21	2	2	1	2	-	1	-	,	6	7			•			. 1
WET OXIDATION O NO ANAL WASH	27	1	-	1	2	1	1	-	1	6	7			-			2
SEMIAUTOMATIC BAG SYSTEM (SKYLAB) o NO ANAL WASH	-	1	6	-	2	-	1	7	-	3	-						0
DRY BAGS	-	•	_	-	-		-	-	-	 	-		•				0
																	• .

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SPACECRAFT_	Shi	Manta Colloction		
HABITABILIT	Y SUBSYSTEM Person	al Hygiene HABITAB	ILITY FUNCTION	Waste Collection, Transfer
APPLIANCE F	UNCTION Fecal Colle	ection/Transfer		
APPLIANCE C	ONCEPT NO./TITLE	1/Dry John		
INDEX NO.	2.1.1.1	REF. NO	o. <b>207,</b> 209,250	, & 273

DESCRIPTION The dry john commode assembly serves as a waste collector and feces storage/processing unit. The seat is similar to the terrestrial type with modifications necessary for zero-gravity usage. The feces are transferred to the storage/processing section (collector) via the fecal transfer duct. The fecal transfer duct contains provisions for entrainment airflow for separating and moving the stool from the anus to the collector. Air positioning jets shown on the schematic are used to assist the user in positioning properly on the seat. This portion of the system was not considered part of the appliance, since recent tests have shown the jets are not necessary. The interface between the transfer duct and the feces collector is the collector valve. The valve is manually actuated and seals the collector after use to permit vacuum drying of the feces. A sunger is incorporated to maximize the feces and wipes area exposed to vacuum by depositing the feces and wipes on the wall of the collector. Entrainment air and air removed by the vacuum pump are passed through filters and returned to the cabin. The schematic does not show a vacuum pump; however, the vacuum pump was added to the appliance concept to satisfy the vehicle requirement of no venting external to the spacecraft.



	/N	•		PENALTIES CALC	INDEX	NUMBER <u>2.1</u>	1.1.1
• •	ELEC	IRICAL P	OWER	REQUIRE	MENTS		
is m	<u> </u>	A C	POWE	R ·	DC	POWE	R
	USE TIME		3	(4) Demand (Watt-HR/	<b>(</b> 5)	<b>©</b>	. DI
COMPONENT (1	CYCLE REF) (HR)	PEAK (WATTS)	AVERAGE (WATTS)	CYCLE)	PEAK (WATTS)	AVERAGE (WATTS)	`cy
BONEST MOTOR (		75	60	_6			
	209) _10	250	180 200	18	,		<u>.</u> 
VACOUMPAMP (2 SOLENOID VALVEY		350 TARY —	<u> </u>		_32_	32	•
CONTROLLERIAME	n(201)15				<u>30</u>	_20_	
• • • • • • • • • • • • • • • • • • • •		_			•		-
	•	675		34	62	•	
		MAXIMUM		TOTAL	MAXIMUM		. T
					en e	•	
			•		· · · · · · · · · · · · · · · · · · ·	•	
•	•		•	•	•		
		THERMAL.		REMENTS			1.
source	i instru	LATENT (BTU/HR)	• .	SIBLE J/HR)	HEAT LEAK (BTU/HR)		COOLA BTU/HR
Some Gill mo	TOR	<u> </u>	_10	3.3	103.3		
AIR FAN	· · · · · · · · · · · · · · · · · · ·	•	34	4/	341.0	_	
	p .		23	38.7	238.7	•	
VACUUM PUN				Control of the second	•: · · · · · · · · · · · · · · · · · · ·		
VACOUM PUM							
VACOUM PUM					•	- -	
VACOUM PUM			200.3	(683)	200.3 (683	 	
VACOUM PUM	TOTAL	WATT (BTU/HR)	200.3 WATT (	(683) BTU/HR)	200.3 (68:		<b>r (</b> BTU,
VACOUM PUM		WATT (BTU/HR)	200.3 NATT (	(683) BTU/HR)			<b>「(</b> BTU,
VACOUM PUM		WATT (BTU/HR)	200.3 NATT (	(683) BTU/HR)			Г (вти,
VACOUM PUM		WATT (BTU/HR)	200.3 HATT (	(683) BTU/HR)			<b>r</b> (вти,
VACOUM PUM					WATT (BTU/HR)		r (вти,
VACOUM PUM		WATT (BTU/HR)		(683) BTU/HR)  NALIIES	WATT (BTU/HR)		Г (ВТU,
VACOUM PUM	TOTAL	<u>OPERATION</u>			WATT (BTU/HR)	WAT	• • • • •
VACOUM PUM  SOURCE	TOTAL	<u>O P E R A I I O N</u>	AL PE	NALTIES	WATT (BTU/HR)	WAT	• • • • •
	TOTAL	<u>O P E R A I I O N</u>	<u>AL PE</u>	NALTIES	WATT (BTU/HR)	WAT	

KG/CYCLE WATTS/CYCLE KG/MISSION M3/MISSION (FT3/MISSION)

(LD/CYCLE) (BTU/HR/CYCLE) (LD/MISSION)

TOTAL

	FIXED	HEIGHT/V	ALHME DE	N (I T D F M F N T S	
in the second se	TIVER	F F 7 7 11 77 7	WEIGHT	QUIREMENIS	VOLUME
COMPONENT	(REF)		(LBS)		(FT ³ )
Commonelcon	PONENTS (20)	<i></i>	87		3.0
PACKAGING VACUUM PUMI	0	·	105 . 38		26.0
WIPES			6.54	<u></u>	.3
		. , .		<del></del>	
		. <del></del>			
	TOTAL		07.3 (23) KG (LBS)	(0.5)	.84 (29.8) H ³ (FT ³ )
•	SOLID EX	PENDABLE	W T/V O L	REQUIREMEN	<u>T S</u>
	•	(D)	3	4	<b>6</b>
	<b>①</b>	WT/UNIT (REF (PKG.WT/UNIT)	(REF) NT/CYC	) (PKG.VOL/UN	IT)(REF) (1)X(4)
DRY WIPES	UNITS/CYCLE(REF) 3 (250)	(LB), 2.04/196	(LB) (250) .03/2	(F13)	(F13)
		• •			
WET WIPES	(250)_	3.4/70	(250)	6	(250) .60184
			•		
	<del></del>				
		•	∑3 <u>.0798</u> TOTAL WT/ (LB)	CYCLE	∑ ⑤ <u>.0038</u> TOTAL VOL/CYCLE (FT³)
MISSION CYC	ES/DAY X	20.5 AYS/MISSION	X .0798 TOT.WT/CYCL (LB)	Ē	2.97 (6.54)
TOTAL VOL =		20 -			.009 (.313)
MISSION CYCI	ES/DAY XD	AYS/MISSION	x .0038 TOT.VOL/CYC	LE L	M ³ (FT ³ )
			(FT ³ )	ng pagasan ng kalaban ng Kababan br>Kababan ng Kababan ng	tinto di Composito di Paragonia. La composito di Paragonia
	<u>G A S/L I Q U I</u>	<u> </u>	DABLES R	EQUIREMENT	<b>.<u>s</u></b>
		0	<b>0</b>	3	CLE AMT LOST/CYCLE
	AMT. USED/	CYCLE (REF)	RECOVERY	AMT.RECOVERED/CY ① X ② (LB)	0-3 (LB)
TYPE		LB)	FACTOR	(LB)	(LB)
		<u> </u>			
	<del></del>			<del>-</del> <del></del>	30
	Σ ①				Σ@
<b>.</b>					
TOTAL WT.	* •				

	SPACECRAFT	Shuttle,	/		
• .	HABITABILI	TY SUBSYSTEM Pers	onal Hygie	ne HABITABILITY FUNC	Waste Collection, TION Transfer
	APPLIANCE	FUNCTION Fecal C	ollection/	Transfer	
•	APPLIANCE	CONCEPT NO./TITLE	2/Dry J	ohn with Anal Wash	
	INDEX NO	2.1.1.2		REF. NO207,20	9, & 273
	wash. The The addit	e anal wash and ai ion of the anal wa . The anal wash a	r dry elim sh require nd commode		expendable wipes. r duct be rinsed with umed to be recovered

# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT 2/URY JOHN INNIC LUNS 4

INDEX NUMBER 21.1.2

•	EL.ECI	•	POWER	REQUIRE			
	(I)	<u> </u>		(4)	D C	POWE	(7
	USE TIME	2 PEAK	AVERAGE	DEMAND (WATT-HR/ CYCLE)	PEAK	6 AVERAGE	DEMA (WATT- CYCLE
OMPONENT (REF)	(HR)	(WATTS)	(WATTS)	CYCLE)	(WATTS)	(WATTS)	① X
<u> 5UNGITE MOTOR (209)</u> <u>9UR HEDI TER</u> (209)	.167 .050	80	_60_	10.02	350	300	15
CLENOID WHILLY SYZY)	MCMCNIBR.				40	40	
DRFTIN (201) DNTPOLUPLITINI=T(20	<u>elle7</u>	250	180_	30.06	30	20	4
YNCVVM FYMP (20))		350	200	10			
				• \	<u> </u>		
-		•	<del></del>			<del></del>	· • • •
	•	680		50.1	420		19.
	•	MAXIMUM .	•	TOTAL	MUMIXAM		. <b>7</b> 0T
				er a		•	•
•	•		•	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		•	•
Commence of the Commence of th	•		•		• }	100	•
	1	HERMAL.	REQUI	REMENIS			
	•	LATENT	eru •	SIBLE	HEAT LEAK	70	COOLANT
SOURCE		(BTU/HR)		U/HR)	(BTU/HR)		STU/HR)
HENTED WATER		_	3	94	394		
HEATER AIR		٠	_2	38	_288		
SEINGER MOTOR	····			31.4	181.4		
AIR FAN	-		_5	67.6	567.6		
VACUUM PUMP	<u> </u>		_2	38.4	238.4	•	·
<b>X</b>	TOTAL _	e ve	474	(1619.4)	474 (1619.	4)	
		WATT (BTU/HR)		(BTU/HR)	WATT (BTU/HR)	· ====	(BTU/H
		•			in the second of		
<b></b>							
MALI PAGE 16							
OOR QUALITY	<u>0</u>	PERATIO	NAL PE	NALTIES			•
	Pupru	DANI C	THEOLES	El FATALA	18 1010		) (0) (0):
•	EXPEN		THERMAL	ELECTRICAL (PK WATTS/CY			OLUME MISSIO
SOURCE	(LR/C	YCLE) (RT	U/RK/CYCLE1	TEV MOVIDATION			
SOURCE	(LB/C	YCLE) (BT	U/HR/CYCLE)	(LV MVI 12) CI	(20/11/03/0		

TOTAL

KG/CYCLE (LB/CYCLE)

WATTS/CYCLE (BTU/HR/CYCLE) KG/MISSION (LB/MISSION)

(FE3/MISSION)

#### APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED) CONCEPT Z/DRY JOHN/ANAL WASH INDEX NUMBER 2.1.1.Z FIXED WEIGHT/VOLUME REQUIREMENTS VOLUME (FT3) WEIGHT (LBS) COMPONENT .(REF) COMMODIE COMPONIENTS (2078/209) PACKAGING (207/201) PROCESSING COMPONENTS (2019209) PACKAGING (207,9209) ORIGINAL PAGE 18 OF POOR QUALITY TOTAL 234 1.59 KG (LBS) M3 (FT3) -SOLID EXPENDABLE W T/Y O L <u>REQUIREMENTS</u> VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT³) WT/UNIT (REF) (PKG.WT/UNIT)(REF) (3) WI/CYCLE UNITS/CYCLE(REF) (LB) TYPE $\overline{\Sigma 3}$ $\Sigma$ ${}_{f 5}$ TOTAL VOL/CYCLE (FT3) TOTAL WT/CYCLE (LB) TOTAL WT. = DAYS/MISSION CYCLES/DAY TOT.WT/CYCLE KG (LB) (LB) TOTAL VOL . TOT. VOL/CYCLE (FT3) M3 (FT3) CYCLES/DAY DAYS/MISSION GAS/LIQUID EXPENDABLES REQUIREMENTS AMT LOST/CYCLE 1 - (3) (LB) AMT . RECOVERED/CYCLE . ② (1) RECOVERY ŰXØ (LB) AMT.USED/CYCLE(REF) (LB) **FACTOR** NIA WATER (MALWASH) 1.65 (207) WATER (COMMODE 1.65 (201) RINSE)

270.6.

 $\Sigma$   $\odot$ 

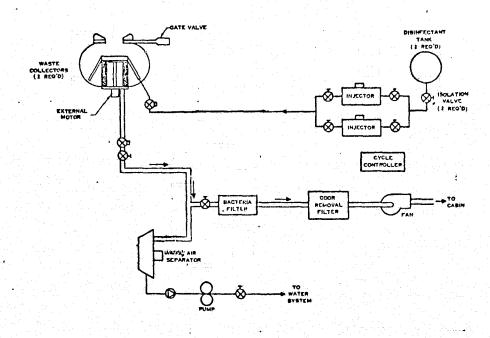
3.30

122.7(270,6

Σ 10 _330

SPACECRAFT	Shuttle		•		· sa i
<del>-</del>	Y SUBSYSTEM Persona	al Hygiene	 _HABITABILITY	FUNCTION	Waste Collection Transfer
APPLIANCE FO	UNCTION Fecal Col	lection/Tr	ansfer		
APPLIANCE CO	ONCEPT NO./TITLE	3/Liqui	d Germicide		
INDEX NO	2.1.1.3		REF. NO. 100	,207,209,	244,250, & 273

DESCRIPTION The liquid germicide commode assembly incorporates a strong biocidal agent throughout the excreta to kill the microorganism population and maintain sterility in storage. The waste collector is provided with a blender and germicidal metering equipment. The blender is used to ensure thorough mixing of the wastes and germicide. The collector gate valve is open only during waste collection. When the container is full, the tank is sealed, removed to storage, and replaced with an empty tank. The waste collectors are sized for replacement every 50 days. Some liquid is recovered, separated, and returned to the water waste management system. Air entrainment of the feces as previously described in Concept 1, is utilized with the air returned through filters to the cabin. The collector when transferred to storage will weigh 332 pounds. Wet and dry wipes are used for this concept and are assumed to be deposited into the collector. The concept was not given credit for liquid recovery, since the majority of the liquid is held in the collector.



# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT 3/LIQUID GLAZALICIDE

INDEX NUMBER 2.1.1.3

	ELECTRICAL P	OHER REQUIRE	WENTS	ı
	FFEFTUTEEF I		7-7-7	POWER
MPONENT (REF)	USE TIME (2) CYCLE PEAK (HR) (WATTS)	3 DEMAND AVERAGE (WATT-HR/ CYCLE) (WATTS) ① X(3)	⑤ PEAK AVE	(f) DEMANI RAGE (WATT-HI CYCLE)
ENDR MOTER (109,709) LENOIWALVE (2)	.158	100 5	16	16 =
IRITAN ASSENIBLY ONTROUGH/TUMER _	.158 <u>250</u> .158 <u>-</u>	<u>180</u> <u>28.4</u>	30 2	20 , 3.2
	400 MAXIMUM •	33.4 TOTAL	46 MAXIMUM	3,2 TOTAL
	IHERMAL.	<u> </u>		
SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
RENDER MOTOR	NHA.	<u>102.3</u> 539.9	<u>102.3</u> 539.9	N/A

BLENDER MOTOR HA 102.3 102.3 14A

BLENDER MOTOR HA 539.9 539.9 N/A

ONCLUDES SEPTIMATORS

TOTAL - 188.3(642.2) 188.3(642.2)
WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)

ORIGINAL PAGE IS OF POOR QUALITY

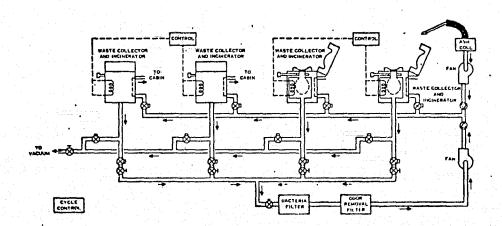
### OPERATIONAL PENALTIES

	SOURCE		HEAT LEAK (BTU/HR/CYCLE)	MAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT3/MISSION)
NIA							
							•
				•			
		TOTAL					e de la Santable de la Colonia
		IUIAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)

### APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED) CONCEPT 3/LIQUID GORMICIDE INDEX NUMBER 2.1.1.3 FIXED WEIGHT/VOLUME WEIGHT (LBS) VOLUME (FT3) LIG. GERMICING SYS. (100, 244) WETIORY WIPES 125.4 (276.5) TOTAL ORIGINAL PAGE IS 2.02 OF POOR OUALITY KG (LBS) M3 (FT3) . EXPENDABLE WI/VOL VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT3) WT/UNIT (REF) (PKG.WT/UNIT)(REF) (LB) UNITS/CYCLE(REF) 2.04/196 (250) .0312 .129/196 (250) DRY WIPES 3.4/70 (250) .0486 GAS/LIQUID EXPENDABLES REQUIREMENTS AMT LOST/CYCLE 1 - 3 (LB) . ② AMT.RECOVERED/CYCLE RECOVERY AMT. USED/CYCLE (REF) ① X ② **FACTOR** LIQUID GERMICIDE $\Sigma$ 4 .615 $\Sigma$ 0 615 . 50.43 · N/A

SPACECRAFT	<u>'Sh</u>	nuttle	Waste Collection/
HABITABILITY S	UBSYSTEM Person	nal Hygiene HABITABILITY FUNCTI	
APPLIANCE FUNC	TION Fecal Col	llection/Transfer	
APPLIANCE CONC	EPT NO./TITLE_	4/Integrated Vacuum Decomposit	ion
INDEX NO. 2.	1.1.4	REF. NO. 100,250, &	Skylab data

high temperature to decompose the waste materials into gaseous products which can be exhausted to vacuum. The chamber requires cooldown and must be vacuumed at the end of the cooldown period. The process does not require oxygen; however, requires power to sustain the chemical process for 12 hours. Six commodes were assumed to be required due to the 12-hour cooldown time (i.e., one unit can be used once per day). Incinerable collection bags with a hydrophobic patch (Skylab type utilized) were used to eliminate the maintenance and microbiological problems of filter replacement, since clogging is not anticipated with collection bags which are replaced every 24 hours. The residual ash was not considered as a concept penalty. Air entrainment of the feces, as previously described in Concept 1, is utilized with the air returned through filters to the cabin. Wet and dry wipes are used for this concept and are assumed to be deposited into the collector.



# D2:118561-2

# CONCEPT 4/INTEGRATED VACUUM DECOMPOSITION INDEX NUMBER 2.1.1.4

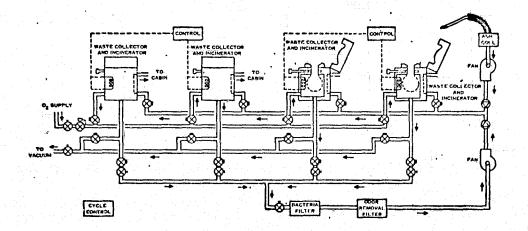
	_		LPUWE	K	<u> </u>	PUW	<u> </u>
	USE TIME	2	3	DEMAND	<b>⑤</b>	<b>6</b>	DEMAND
				(WATT-HR/		AVERAGE	WATT-HR/
Service Control of the Control of th	CYCLE	PEAK	AVERAGE	CYCLE)	PEAK		CYCLE)
COMPONENT (REF)	(HR)	(WATTS)	(WATTS)	(Dx3)	(WATTS)	(WATTS)	① x ⑦
AIR FAN ASSY (100)	12	500	360	4320			
	GMUNITHEY				40	40	
					40	40	
	MENTALY					1000	. 12000
HEATER	12				1000		
CONTROLLER/TIMUR_	24				30	_20	480
		<u> </u>	<del></del>				<u>.</u>
		·		, ·			
	·	• .					
				•			
		500		4320	1110	•	12480
		MAXIMUM	•	TOTAL	MAXIMUM	•	TOTAL
		F#30 11 10 11		TOTAL	7 (* (* ) (* )		
		•		. •			
•			•	•			" · • · · ·
	•				د	. •	· • ·
			•		· · · · · · · · · · · · · · · · · · ·		
<u></u>	•	HERMAL		REMENTS		•	
			VERFF	7 F G F G T 5			•
		4 400				• 1 1	TO COOLANT
•	•	LATENT	•	SIBLE	HEAT LEAK		
SOURCE		(BTU/HR)	<b>(B</b> T)	U/HR)	(BTU/HR)		(BTU/HR)
			•				
FAN ASSY				710	_1710	<del></del>	
HEATERS		•	34	110	3410		
		<del></del>	- <del></del>	<del></del>		-	
		<del></del>	—				
		•			•	•	••
			- <del> </del>				
			- 120 - <del>- 11</del>	<del></del>	·	<del></del> ,	<del></del>
			1400	2 ·	1000 (-1	2	
TO	TAL		1499	<u>(5120)</u>	1499 (51	<u> </u>	
	V	ATT (BTU/HR)	WATT	(BTU/HR)	WATT (BTU/HF	₹)	WATT (BTU/HR)
		•					•
	•			•			1,
				•			
	•	•				· · · · · · · · · · · · · · · · · · ·	
			•				
	. O P	ERATIO	NAL PE	NALTIES		,	
				7777	•		
		THERMAL		ELECTRICAL	WEIGH	<b>T</b>	VOLUME
SOURCE	HEAT L (BTU/HR/C)		O COOLANT	(PK WATTS/C)		1 1	(FT3/MISSION)
SOURCE	(BTU/TIK/C	ICLE) (B	IO/IIN/GIGEE/	(FR AMITS)	(20/11/03		(, , , , , , , , , , , , , , , , , , ,
KI/A							
IVIA		<del></del> , <del></del>	<del></del> _		<del></del>		
		<u> </u>					
						1 4 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1	
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			•				أحبت والمجانب
			ariin d				
	-	<del></del>		-			• <del>••••••••••••••••••••••••••••••••••••</del>
	<b>N</b>					•	
TOTA	NATTS/	CYCLE	WATTS/CYCLE	· <del></del>	KG/MISS	ION	M3/MISSION
	(BTU/IIR		BTU/HR/CYCLE)		(LB/MISS	ION)	(FT3/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS. (CONCLUDED)

CONCEPT 4/INTEGRATED VACUUM DECOMPOSITION INDEX NUMBER 2.1.1.4-

TOTAL   163.5   360.5   3.61 (127.3   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5   10.5	OMPONENT - (REF	WEIGHT (LBS)	VOLUME (FT ³ )
TOTAL   163.5 (360.5)   3.61 (127.3.   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0005   100.0			127
TOTAL		6.54	.3
TOTAL			•
TOTAL   163.5 (360.5)   3.61 (127.3)    INCLUDES INTIMAL WEIGHT OF COLLECTOR ANGS (185)   N3 (FT3)    \$ 2011 D EXPENDABLE MITTY OF COLLECTOR ANGS    \$ 2011 D EXPENDABLE MITTY OF COLLECTOR ANGS    ONTO WITTY OF COLLECTOR ANGS   VIOLATIT (REF)   VIOLATIC (REF)			
101AL   1/63.5   360.5   3.61 (127.3)			
101AL   1/63.5   360.5   3.61 (127.3)	- G		
NCCUDES   INITIAL WEIGHT OF COLLECTOR ANGS   N3 (FT3)			
KG (LBS)		•	
NCLUDES   INITIAL WEIGHT OF COLLECTOR ANGS		The second secon	The second secon
SOLID EXPENDABLE HIVOL REQUIREMENTS  SOLID EXPENDABLE HIVOL REQUIREMENTS  WITHINGTON (PROCULINITY) (REF)  O	· <b>T</b> OTA	163.5 (360.5)	3.61 (127.
SOLID EXPENDABLE HIVOL REQUIREMENTS  WITOUNIT (REF)  WITOUNITY  WITOUNI		KG (LBS)	M ³ (FT ³ )
TYPE UNITS/CYCLE (REF) (PKG. WT/UNIT) (REF) (DX			
### TYPE UNITS/CYCLE (REF)	ZĀFIĀ ĒŸ		
TYPE UNITS, CYCLE (REF) (LB) (FF3) (		WT/UNIT (REF) WT/CYCLE	VOL/UNIT (REF) VOL/CYCLE
Company   Comp		(LB) (LB)	(FT ³ )
DITAL WIL WILSTION X ZO.5 X 309 TOT. WITCYCLE (LB)  OTAL WIL WIL CYCLE (LB)  OTAL WOL WILSTION X ZO.5 X 309 TOT. WITCYCLE (LB)  OTAL WOL WILSTION X ZO.5 X 309 TOT. WITCYCLE (LB)  OTAL WOL WILSTION X ZO.5 X 309 TOT. WITCYCLE (LB)  OTAL WOL WILSTION X ZO.5 X 309 TOT. WITCYCLE (LB)  OTAL WOL WILSTION X ZO.5 X 309 TOT. WITCYCLE (LB)  OTAL WOL WILSTION X ZO.5 X 309 TOT. WITCYCLE (LB)  OTAL WOL WILSTION X ZO.5 X 309 TOT. WITCYCLE (LB)  OTAL WOL WILSTION X 300 TOT. WITCYCLE (LB)  OTAL WITCYCLE (LB)  OTAL WITCYCLE (LB)  OTAL WOL WITCYCLE (LB)  OTAL WITCYCLE (LB)  OTAL WOL WITCYCLE (LB)  OTAL WOL WITCYCLE (LB)  OTAL WOL WITCYCLE (LB)  OTAL WOL WITCYCLE (LB)  OTAL WOL WITCYCLE (LB)  OTAL WITCYCLE (LB)  OTAL WOL WOL WOL WOL WOL WOL WOL WOL WOL WO		• • • • • • • • • • • • • • • • • • • •	
OTAL WIT.  OTAL WIT.  ATTERISTON  TOTAL WIT.  AND TOTAL WIT.			
TOTAL WT. (LB)   ociegor boas 1 (100	229 (SKY(AB) . 229	.0068 (SKYCAB) .0068	
TOTAL WT. (LB)			
TOTAL WT. (LB)			
TOTAL WT. (LB)			
OTAL WT.  MISSION  CYCLES/DAY  X  ZO.5  X  JOHNSSION  TOT. WT/CYCLE (LB)  OTAL VOL  MISSION  TOT. VOL/CYCLE (FT3)  CYCLES/DAY  X  ZO.5  X  JOHNS  CYCLES/DAY  X  ZO.5  ZO.5  ZO.7  ZO.		TOTAL WT/CYCLE	TOTAL VOL/CYC
TYPE  AMT. USED/CYCLE (REF)  TOTAL VOL  MISSION  CYCLES/DAY  X  ZO.5  X  TOT. WIT. CYCLE  (LB)  TOT. VOL. (LB)  TOT. VOL. (CYCLE  (FT 3)  AMT. RECOVERED/CYCLE  AMT. LOST/CYCLE  (LB)  TYPE  TYP	OTAL UT	(LB)	(FT ³ )
OTAL VOL MISSION  AT X ZO.5 X OIGG  CYCLES/DAY  DAYS/MISSION  TOT.VOL/CYCLE  (FT3)  OAS/LIQUID  EXPENDABLES  REQUIREMENIS  AMT. RECOVERY  FACTOR  TYPE  AMT. USED/CYCLE (REF)  (LB)  AMT. RECOVERED/CYCLE  (LB)  TYPE  TYPE  AMT. USED/CYCLE (REF)  FACTOR  (LB)  TOT.VOL/CYCLE  (FT3)  AMT. RECOVERED/CYCLE  (LB)  TYPE  AMT. OST/CYCLE  (LB)  TYPE		Zo.5 x .309	
CYCLES/DAY  DAYS/MISSION  TOT.VOL./CYCLE  (FT3)   GAS/LIQUID  EXPENDABLES  REQUIREMENTS  AMT.RECOVERD/CYCLE  AMT.USED/CYCLE(REF)  FACTOR  AMT.RECOVERD/CYCLE  AMT.LOST/CYCLE  (LB)  TYPE  AMT. USED/CYCLE(REF)  FACTOR  TYPE  TYPE  AMT. USED/CYCLE  (LB)  TYPE  AMT. USED/CYCLE  (LB)  TYPE  AMT. USED/CYCLE  (LB)			KG (LB)
CYCLES/DAY  DAYS/MISSION  TOT.VOL./CYCLE  (FT3)   GAS/LIQUID  EXPENDABLES  REQUIREMENTS  AMT.RECOVERD/CYCLE  AMT.USED/CYCLE(REF)  FACTOR  AMT.RECOVERD/CYCLE  AMT.LOST/CYCLE  (LB)  TYPE  AMT. USED/CYCLE(REF)  FACTOR  TYPE  TYPE  AMT. USED/CYCLE  (LB)  TYPE  AMT. USED/CYCLE  (LB)  TYPE  AMT. USED/CYCLE  (LB)	TAL VOL 4 x	20.5 x .0106	• 024 (87
GAS/LIQUID EXPENDABLES REQUIREMENTS  AMT.USED/CYCLE(REF)  (LB)  TYPE  AMT.USED/CYCLE(REF)  FACTOR  AMT.RECOVERD/CYCLE  (LB)  AMT.RECOVERD/CYCLE  (LB)  (LB)  TYPE	CYCLES/DAY A	DAYS/MISSION TOT.VOL/CYCLE	
TYPE  AMT. USED/CYCLE (REF)  (LB)  RECOVERY FACTOR  AMT. RECOVERED/CYCLE ON (LB)  AMT. RECOVERED/CYCLE ON (LB)  AMT. RECOVERED/CYCLE ON (LB)  TYPE  TY			
TYPE  AMT. USED/CYCLE (REF)  (LB)  RECOVERY FACTOR  AMT. RECOVERED/CYCLE ON (LB)  AMT. RECOVERED/CYCLE ON (LB)  AMT. RECOVERED/CYCLE ON (LB)  TYPE  TY	and the second of the second o		
TYPE  AMT. USED/CYCLE (REF)  FACTOR  AMT. RECOVERED/CYCLE  TYPE  (LB)  AMT. RECOVERED/CYCLE  (LB)  AMT. RECOVERED/CYCLE  (LB)  TYPE	6 k 3/L 1 Q D 1		
TYPE  (LB)  FACTOR  (LB)  (LB)  (LB)  (LB)		(1)	RECOVERED/CYCLE AMT LOST/CYCL
$\Sigma \odot$	TYPE AMT. USED	(LB) FACTOR	$ \begin{pmatrix} (LB) & (LB) \\ (LB) & (LB) \end{pmatrix} $
$\Sigma \odot$		and the second s	en en la la companya de la companya
$\Sigma \odot$			
Σ Φ			
$\Sigma$ $\odot$ $\simeq$			
$\Sigma$ $\odot$ $\simeq$			
	$\sum 0$		Σ @
11701 W.I	E .		

SPACECRAFT 'SI	<u>huttle</u>	
HABITABILITY SUBSYSTEM Perso	onal Hygiene HABITABILI	Waste Collection/ TY FUNCTION Transfer
APPLIANCE FUNCTION Fecal Co	ollection/Transfer	
APPLIANCE CONCEPT NO./TITLE	5/Flush Flow Oxygen	Incineration
INDEX NO. 2.1.1.5	REF. NO	100,250, & Skylab data
for a specified time period vapors are exhausted to specified to specified time period to specific to bring the incineration oxygen is continuously suppractive approximately 12 hours likely hours are allowed for collection bags described	mber for the 12 hours ry same process of air e in the chamber (no vent d. The resulting steril ace. The valve is left temperature to 1000°F, plied to the chamber. Tre with 97 to 99 percen or cooldown which requiin Concept 4 are also u	equired for incineration. ntrainment used on the to vacuum), heat is applied ized/vaporized gas and open and heat is applied while a controlled flow of he incineration process t reduction in process waste. res one commode per man. The



# CONCEPT S/RUSH ROW OXIGEN INCINETRATION

INDEX NUMBER Z.1.1.5

CUNCEPT ST PECAL	ELĒČI			- REQUIRE	MENTS	• • •	
•				R	D C	POWI	R
COMPONENT (REF)	USE TIME CYCLE (HR)	PEAK (WATTS)	AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) (1) X(3)	PENK (WATTS)	6 AVERAGE (WATTS)	(7) DEMAND (WATT-HR CYCLE) ① X ⑦
AIR FAN ASSY. (100) SOLENOW VALVES(S) VICUUM VALVES(S) OzVALVES (S)	<u>1Z</u> nomasiney 	<u>500</u>	_360 	4320	40 40 40	40 40 40	
HEATER CONTROLLER/TIMER	12 24				500	500 20	480
		500 MAXIMUM		4320 TOTAL	650 MAXIMUM		6480 TOTAL
\$ SOURCE	<b>.</b>	LATENT (BTU/HR)	SEN	REMENIS STBLE U/HR)	HEAT LEAK (BTU/HR)		TO COOLANT
AIRFAN MOTOR		NIA	/-	705	1705		NILA
HEATURS		MA		380	2380		N/A
	TOTAL _	MATT (BTU/HR)		3 (4025) (BTU/HR)	1 <u>198 (408</u> WATT (BTU/HR		ATT /BTU/HR
							ξ`.
	<u>0</u>	<u>P E R A T 1 0</u>	NAL PE	NALTIES			
SOURCE	HEAT (BTU/HR/C	THERMAL LEAK T CYCLE) (BT	O COOLANT U/HR/CYCLE)	ELECTRICAL (PK WATTS/CY			VOLUME T ³ /MISSION)
N/A -					•		
<u>,                                     </u>	<del></del>						

WATTS/CYCLE (BTU/HR/CYCLE) KG/MISSION (LB/MISSION) M3/MISSION (FT3/MISSION)

TOTAL

WATTS/CYCLE (BTU/HR/CYCLE)

#### APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED

	FIXED	<u>W E I G H I/V (</u>	DIUME REQ	<u>U.I.R.E.M.E.N.T.S</u>	S	
COMPONENT COMMODE AS	(REF)	/	WEIGHT (LBS)		VOLUME (FT ³ ) /23	÷
WET/DRY U	UIPES		6.54		.3	
		-				,
						<del></del>
tvari Politika	TOTAL	1_/	71.7 (378) KG (LBS)		3,49 (2 M³ (FT³) ·	?3.3)
* INCLUDES W		CLECTOR ENDABLE (2)		EQUIREME	_ ; = = = .	্ব জ
TYPE	の UNITS/CYCLE(REF) ろ(こら)	WT/UNIT (REF (PKG.WT/UNIT)( (LB). 2.04/196(	) WT/CYCLE REF) ① X ② (LB)	(PKG.VOL/U	JNIT)(REF) ①X	(4) 2)
DRY WIPES	$\frac{3}{(250)}$	3.4/70	(25) <u>.0312</u> (25) <u>.0486</u>	•	16 (250) 20079 D (250) 20079	
COLLECTOR BAGS	(1(100)	·553 (?):	<u> </u>	.0068	(X703).006	<u>8</u>
			309 TOTAL VIT/CY (LB)	CLE	Σ ⑤	G DL/CYCLF 13)
MISSION CYCL	4 xx	20.5 AVS/MISSION	X	_ • E	11.5 (Z.	5.3)
TOTAL VOL = CYCL		20.5 AYS/MISSION	X	_ • · · · · · · · · · · · · · · · · · ·	.024 (.8	ર્કલ્9)
	GAS/LIQUI	<u>EXPE</u> N	<u>DABLES RE</u>	QUIREMEN	<u>.</u>	
	. AMT. USED/	O CYCLE (REF)	@ RECOVERY	MT.RECOVERED/O	•	
TYPE OXYGEN			FACTOR N/A	(LB)	(LB .42	

TYPE	AMT. USED/CYCLE (REF) (LB) 428	RECOVERY FACTOR	AMT.RECOVERED/CYCLE ① X ② (LB)	AMT LOST/CYCLE ①-③ (LB) .428
$\sum_{i,j}$	.428		Σ⊚	.428
TOTAL WT. 4 MISSION CYCLE/DAY	20.5 DAYS/MISSION X 101/	428 35. NL LOST/CYCLE (LB)	<u> </u> + <u>  / </u>	15.9 (35.1)

SPACECRAFT Shuttle

HABITABILITY SUBSYSTEM Personal Hygiene HABITABILITY FUNCTION Transfer

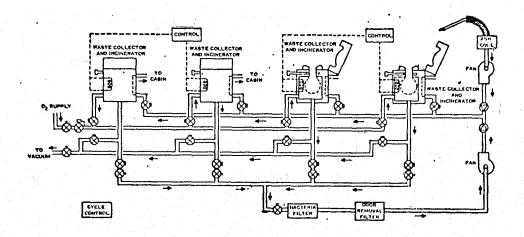
APPLIANCE FUNCTION Fecal Collection/Transfer

APPLIANCE CONCEPT NO./TITLE 6/Pyrolysis/Batch Incineration

INDEX NO. 2.1.1.6 REF. NO. 100,250, & Skylab data

DESCRIPTION The pyrolysis/batch incineration concept utilizes a three-step process to minimize oxygen consumables. The wastes are heated to 250°F and

process to minimize oxygen consumables. The wastes are heated to 250°F and held at this temperature for 30 minutes to ensure sterilization. The vent valve is then opened and the water is flashed to space as a vapor. The chamber is then heated to 1200°F, with the vacuum valve remaining open, and the wastes are pyrolytically decomposed (vacuum decomposition) and the gases are vented to space. At the end of the pyrolysis process, the vent valve is closed, the chamber is charged with oxygen, and several batch incinerations are performed. The batch incineration step reduces the ash residue from 12 to 2 percent of the total wastes processed. After final venting to space, the chamber cooldown takes 12 hours. The pyrolysis/batch incineration process is identical to the schematic shown for Concept 5. The pyrolysis/batch incineration takes 12 hours. The collection bags described in Concept 4 are also used for this concept. Wet and dry wipes are used for this concept and are assumed to be deposited into the collector.



# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT 6/PYROLYSIS/BUTCH INCINGENTION

INDEX NUMBER 2.1.1.6

		IRICAL PO	<u>POWER</u> R	EQUIRE	D	C PON	
· · · · · · · · · · · · · · · · · · ·	USE TIME	2	3	DEMAND (WATT-HR/	(5)	<b>©</b>	(7) DEMAND (WATT-HR/
CMPONENT (REF)	CYCLE (HR)	PEAK (WATTS)	AVERAGE (WATTS)	CYCLE)	PEAK (WATTS)	AVERAGE (WATTS)	CYCLE)
UR FAN ASSY (100)	12	500	360	4320	(MA113)	(#6/13)	- 0.0
OLENOID VALVES (1)					40	40	
IACUUM VALVES (7)					40	40	<u> </u>
2. VALVES (7) HEATER	12				1000	40	IZOCO
ONTROUER/TIMES		-		١ ــــــ	30	20	480
		•	<del></del>				
	. <del> </del>					<del></del>	<del></del>
	•	500	•	4320	1150	•	1248
		MAXIMUM .	•	TOTAL	MAXIMUM	•	TOTAL
		•				• . * 1	•
		•	•		•		1
			•	· ·			
		THERMAL.	<u>R.E.Q.U.1 R</u>	<u>EMENIS</u>		•	
s SOURCE		LATENT (BTU/HR)	SENSI (BTU/		HEAT LEAK (BTU/HR)	• 1	TO COOLANT (BTU/HR)
				•			
HIK FAN MOTOK		N/A	170	25_	1705		N/A
•	<del></del>	N/A N/A	_170	T	1705	- - -	N/A N/A
AIR FAN MOTOR HEATER				T			NIA
•	- 6			T			N/A N/A
•	• •			T	3410		NIA
•			34/	<u>'0</u>	3410		NIA
	TOTAL	MA	341 	(5115)	3410 - 1500 (S.	<u>.</u>	N/A -
•	TOTAL		34/	(5115)	3410	<u>.</u>	N/A
	TOTAL	MA	341 	(5115)	3410 - 1500 (S.	<u>.</u>	N/A
•	TOTAL	MA	341 	(5115)	3410 - 1500 (S.	<u>.</u>	N/A
•	TOTAL	MA	341 	(5115)	3410 - 1500 (S.	<u>.</u>	N/A
•		MATT (BTU/HR)	1500 ( MATT (B	(5/15) TU/HR)	3410 - 1500 (S.	<u>.</u>	N/A
•		MA	1500 ( MATT (B	(5115)	3410 - 1500 (S.	<u>.</u>	NIA

----

TOTAL

WATTS/CYCLE (BTU/HR/CYCLE) WATTS/CYCLE (BTU/HR/CYCLE) KG/MISSION (LB/MISSION)

M³/MISSION (FT³/MISSION)

### APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS. (CONCLUDED)

the state of the s		•	•	
CONCEPT 6/ PYROLYSIS / BATCH	INCINURATION			INDEX

INDEX NUMBER Z.1.1.6

COMPONENT - (REF)	WEIGHT (LBS)	•	VOLUME (FT³)
comment ASSY * (100)	372		91
WETIDEY WIPES	6.54		-3
•			
			•
			•
		•	
		· · · · · · · · · · · · · · · · · · ·	
Surject Surjection			•
TOTAL	171.7 (378.5)	2.	58 (91.3)
A MENTALE MATERIAL MATERIAL	KG (LBS)		M3 (FT3)
* INCLUDES, INITIAL WEIGHT OF			
<u>SOLID</u> <u>EXPE</u>		UIREMENTS	
	WT/UNIT (REF) WT/CYCLE	VOL/UNIT (REF)	101 15 YOU E
· • • • • • • • • • • • • • • • • • • •	WT/UNIT (REF) WT/CYCLE KG.WT/UNIT)(REF) ①x②	(PKG.VOL/UNIT)(RE	VOL/CYCLE  (F) ① X ④
TYPE UNITS/CYCLE(REF)	(LB) · (LB)	(FT ³ )	(FT ³ )
DRY WIPES 3 (250) 2	04/196 (250)0312	129/196 (25	0) .001975
WET WIPES 1 (250) 3	9/70 (280) .04.86	729/70 (25	00184
COLLECTOR ELGS / (100) =	.229 (SERIO3) .229	-0063 GKY	rag .0068
			<u> </u>
			<del>-</del>
			<del>-</del>
	50 309		
	$\Sigma$ 3 $309$	$oldsymbol{\Sigma}$ (	5 -0106 TOTAL VOL/CYCLE
	(LB)	•	(FT ³ )
TOTAL WT 4 x ZC	.5 x .309	•	1.5 (25.3)
CYCLES/DAY DAYS/	MISSION TOT.WT/CYCLE	<u> </u>	1,5 (25.3) KG (LB)
	(LB)		
MISSION = 4 x 20	.5 x .0106	.0.	24 (87)
CYCLES/DAY DAYS/	S x .0/06 MISSION TOT.VOL/CYCLE	1	M ³ (FT ³ )
	(FT ³ )		
<u>G A S/L 1 Q U 1 D</u>		IREMENIS	
<b>(</b>	<b>②</b>	.RECOVERED/CYCLE	AMT LOST/CYCLE
. AMT. USED/CYCL	E(REF)	(1) x (2)	(1)-(3)
TYPE (LB)	FACTOR	(LB)	①-③ (LB)
OXYGEN .126	<i>N/A</i>	NIA	.126
	region of the control		
			-
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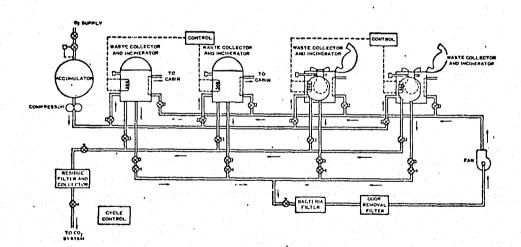
SPACECRAFT Shuttle Waste Collection/
HABITABILITY SUBSYSTEM Personal Hygiene HABITABILITY FUNCTION Transfer

APPLIANCE FUNCTION Fecal Collection/Transfer

APPLIANCE CONCEPT NO./TITLE 7/Wet Oxidation

INDEX NO. 2.1.1.7 REF. NO. 100,250, & Skylab data, 247

DESCRIPTION The wet oxidation concept is a moderate temperature, high pressure catalytic process. The system employs an insulated chamber similar to the incineration and decomposition concepts. Waste treatment is accomplished by charging the chamber with 500 psia oxygen at ambient temperature and applying heat to bring the chamber up to oxidation temperature. The final pressure and temperature are approximately 1750 psia and 550°F. The advantage of the wet oxidation process is the production of water which can be processed and reused in the spacecraft. The system requires a high pressure oxygen source, assumed in this study as a compressor. A stirrer would enhance the wet oxidation process, but was not considered in the study due to lack of engineering data. Based on two data sources, the process was assumed to take 12 hours, most of which is cooldown time (10½ to 6 hours). The collection bags described in Concept 4 are also used for this concept. Wet and dry wipes are used for this concept and are assumed to be deposited into the collector.



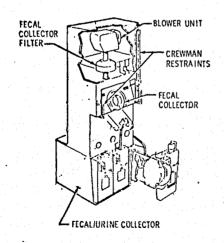
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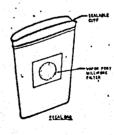
	OXIDATION			<b>&gt;**</b>			•
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	- / , (1) all	20					
	$\Sigma$ 0	<u> </u>			<b>-</b>		

### D2-II8561-2

SPACECRAFT	S	huttle			
HABITABILI	ITY SUBSYSTEM Perso	nal Hygiene HABI	TABILITY	Y FUNCTION	Waste Collection, Transfer
APPLIANCE	FUNCTION Fecal C	ollection/Transf	er		
APPLIANCE	CONCEPT NO./TITLE_	8/Semiautomati	c Bag Sy	stem (Sky	lab)
INDEX NO	2.1.1.8	REF	. NO	Skylab data	a,283,250,100

DESCRIPTION The semiautomatic bag concept consists of a wall mounted fecal collector unit using a collection bag, with air entrainment of the feces. The fecal collector consists of a fecal collection receptacle, a mesh liner, and hinged seat. The hinged seat provides access to the mesh liner to permit manual installation of a fecal bag. The seat is contoured and contains airflow holes to allow cabin air to be drawn into the fecal bag as a gravity substitute airflow. The seat upon closure provides an integral seal between the fecal bag and the fecal collection receptacle and between the seat and the user. A blower unit is utilized to provide feces entrainment into the fecal bag. Cabin air is drawn into the fecal bag and is exhausted through the collection bag's vapor port, through the mesh liner and into the fecal collection receptacle. The cabin air is then passed on to the fecal collector filter and blower unit and returned to the cabin. The fecal bag is manually removed from the fecal collector after each defecation and replaced immediately with a new bag. The fecal bag with its contents is then vacuum dried in a waste processor to facilitate on-orbit storage. The waste processor is a separate unit and is included as a part of this concept.





# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT BISEMIAUTO BAG SYSTEM (SKYLAB)

INDEX NUMBER 21.18

	A.C	POWE		<u>D C</u>	POWER	\ \ 
USE Y	E PEAK	3 AVERAGE	DEMAND (WATT-HR/ CYCLE) ① X ③	(5) PEAK	6 AVERAGE	DEMAN (WATT-H CYCLE)
COMPONENT (REF) (HR	) (WATTS)	(WATTS)	36	(WATTS)	(WATTS)	① x @
AIL FAN ASSY (SKYMB) . Z HENTERS (3) (233) 1	<u> </u>	180	<u> </u>	225	225	22
VACUUM PUMP (2º3) 1 CONTROLLERITIMELERS) 1	350	<u>2∞</u>	200	30	20	
						, <del></del>
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	IHERMAL	R.E QU.1	REMENIS			
	LATENT		SIBLE	HEAT LEAK		COOLANT
SOURCE	(BTU/HR)	<b>(</b> BT)	U/HR)	(BTU/HR)	(B1	(U/HR)
AIR FAN MOTOR	NA		300_	800		1/A_
HEATERS	N/A		168	_768		1/A_
VACUUM PUMP	·N/A		92	1192.		VA_
					•	
TOTAL				909.4(2760	•	0
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					, in	
			• •			
						•
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- N/A -						•
·						
					a America	

B2-153 '

WATTS/CYCLE (BIU/HR/CYCLE) KG/MISSION (LB/MISSION) M3/MISSION (FT3/MISSION)

WATTS/CYCLE (BTU/HR/CYCLE)

### APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT B/SEMIAUTOMATIC BAG SYSTEM (SKYLAB) INDEX NUMBER 2.1.1.8 FIXED WEIGHT/YOLUME REQUIREMENTS WEIGHT (LBS) VOLUME (FT³) COMPONENT (REF) COMMODE/COMPONENTS (SKYLAB) WET DRY WIPES (250) COLLECTION BAGS TOTAL 46.7 KG (LBS) M3 (FT3) . SOLID EXPENDABLE W T/Y O L REQUIREMENTS WT/UNIT (REF) VOL/UNIT (REF) 0 (PKG.WT/UNIT)(REF)
(LB) ①x② (LB) (PKG.VOL/UNIT)(REF) (FT3) UNITS/CYCLE(REF) TYPE 2.04/196(250) 0312 3 (250) .129/196(250) DRY WIPES 0486 3.4/70 (250) WET WIPES 229 309 TOTAL WI/CYCLE TOTAL VOL/CYCLE (FT 3)  $\Sigma$  $_{3}$  $\Sigma$   ${}_{f \odot}$ (LB) MISSION 309 TOT. WT/CYCLE ZOS DAYS/MISSION (25.3)(LB) MISSION 0106 GAS/LIQUID EXPENDABLES REQUIREMENTS AMT.RECOVERED/CYCLE

① X ②

(LB) 0 AMT LOST/CYCLE RECOVERY AMT. USED/CYCLE (REF) TYPE (LB) FACTOR  $\Sigma$  ①  $\sum \Phi$ 

TOTAL LOST/CYCLE

(z (d))

(LB)

(z (1)

KG (LB)

DAYS/MISSION

MISSION

CYCLE/DAY

SPACECRAFT Shuttle

Waste Collection/
HABITABILITY SUBSYSTEM Personal Hygiene HABITABILITY FUNCTION Transfer

APPLIANCE FUNCTION Fecal Collection/Transfer

APPLIANCE CONCEPT NO./TITLE 9/Dry Bags (Apollo)

Apollo dwgs: V36-601029,V36-601398,
INDEX NO. 2.1.1.9 Apollo dwgs: V36-601029,V36-601398,

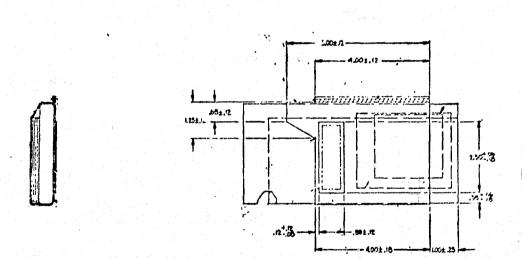
REF. NO. V36-601267,V36-601398,V36-787819,

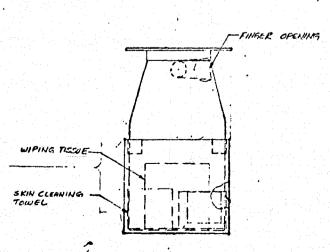
and V36-787809

DESCRIPTION The dry bag concept consists of bag which is taped to the buttocks
of the crewman. The collection system is manual and requires a large amount of
crew time per defecation. The unit is compactly folded for storage and each unit
contains biocide and tissues. The bag is unfolded, taped to the buttocks, the
botus is separated using the built-in finger, and the tissues are deposited into
the bag. The bag is closed, sealed and the biocide is kneeded into the feces

for germicide control. The collection bags are deposited into a large bag which has a capacity for 16 feces collection bags. The dry bags were used on Apollo

and were provided as a backup for Skylab.





APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 9/DEY BAGS (APOLLO)

INDEX NUMBER 2.1.1.9

OMPONENT -	(REF)		WEIGHT (LBS)			VOLUME (FT ³ )
COLLECTION BAC TOWAGE BAG	<del>3</del> S		16.4 3.6	<del></del>	·	
HOWNER BING	2	-				
	•		<del></del>	and the state of t		
			<del></del>		· · · · · · · · · · · · · · · · · · ·	
	•				•	
				·		
	TOTAL		916	201		4 (14)
	TOTAL		9.1 (2 KG (LBS)	20)		, <i>O</i> 4 (1.4) M ³ (FT ³ )
	*		KO (ED3)		•	The Artery
<u>\$</u> .	<u>O L I D</u> <u>E X P</u>	ENDABLE		_	EMENIS	,
	(1)	WT/UNIT (RE	(F) WT/C	3) YCLE VI	OL/UNIT (REF)	VOT\CACTE
	NITS/CYCLE(REF)	(PKG.WT/UNIT) (LB)	(REF) ①X	.B) (PK)	G.VOL/UNIT)(ŔEF (FT³)	(FT ³ )
XLECTION BAGS_			<u>.2</u>	<u> </u>	.0172*	.0172
OWAGE BAGS_	.055	.8		44		
						- <del> </del>
			<del></del>	<del></del>		
<del></del>			$\Sigma$ 3 .24	7 4 IT/CYCLE	ΣΘ	TOTAL VOL/CYCLE
			TOTAL W	IT/CYCLE .B)		TOTAL VOL/CYCLI
OTAL WT.	X ,	<b>20.5</b>	x .24	4 =	9	.1 (20)
CYCLES/	DAY DA	(S/MISSION	TOT.WT/CY (LB)	CLE		KG (LB)
MISSION # 4	x "	20.5	x .017	7		4 (1.4)
CYCLES/	DAY DA	YS/MISSION	TOT.VOL/C (FT ³ )	YCLE	<del></del>	M3 (FT3)
	<u>G A S/L 1 Q U 1 D</u>	EXPEN	DABLES	REQUIRE	MENTS	•
			<b>©</b>		<b>③</b>	AMT LOST/CYCLE
	AMT. USED/C	YCLE(REF)	RECOVERY	AMT.RECO	VERED/CYCLE ) X ② (LB)	AMT LOST/CYCLE ①-③ (LB)
-N/A-	, (LI	3)	FACTOR		(LB)	(LB)
		<del></del>				
ΣΣ	CO				$\sum \bigcirc$	
TAL WT.					•	
				<ul> <li>* Long to the control of the control o</li></ul>		l a company of the co

HABITABILITY SUBSYSTEM	2.0	Personal Hygiene
HABITABILITY FUNCTION_	2.1	Waste Collection/Transfer
APPLIANCE FUNCTION_	2.1.2	Urine Collection/Transfer
NUMBER OF CONCEPTS CONS	SIDERED	5

#### **ASSUMPTIONS**

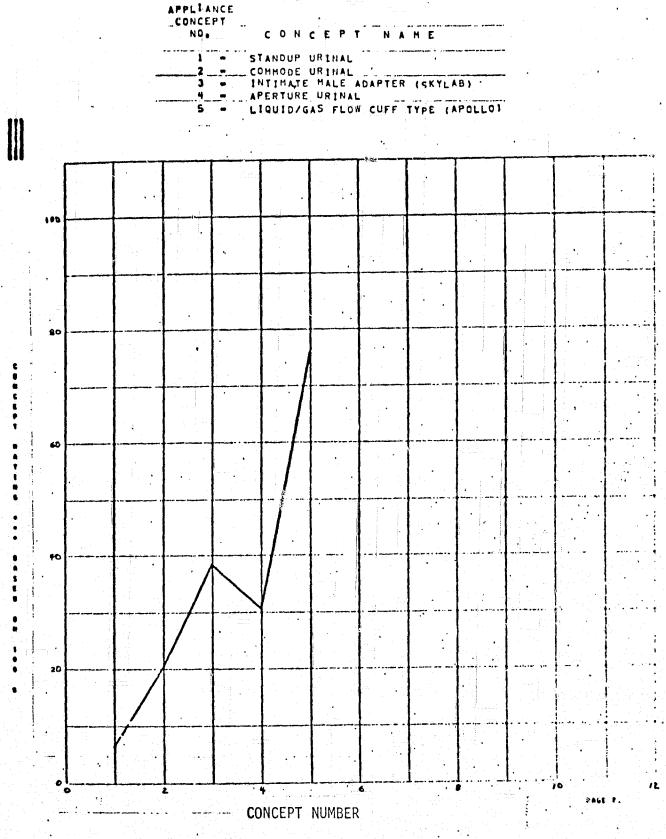
- (1) The urine collection/transfer concepts consider air entrainment and intimate male adapter methods of collecting urine.
- (2) The study assumed a total of 42 urinations per day (seven per day per man). The concept use time required per urination is dependent on the concept type.
  - (3) Filter weight and volume were included if a high replacement frequency is required. Periodic filter replacement was not included in the study.
  - (4) Component power requirements were normalized to provide a fair comparison of all concepts. The power requirements were not based on the latest urine collector designs. This was done because the various manufacturers were in process of a competitive proposal response for the Shuttle waste collection system and could not be contacted for additional information.
  - (5) In the case of Space Station, the urine and rinse water was assumed to be collected and processed through a vapor compression distillation unit. Urine recovery was based on 24.8 grams of solids per 1000 grams of urine. The solids were then ratioed by the amount of flush water used. The recovery factor used was 98.15 percent. The Shuttle concepts were considered to be dumped overboard or collected, but no water processing was applied.
  - (6) The urine collection devices were allocated one per vehicle.
  - (7) The urine collection devices considered are adaptable to men only; however, when combined with a fecal collector, some of the devices can be adapted to females.

0

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APPLIANCE CONCEPT FUNCTION MATRIX
 INDEX NO. 2-1-2 ---- URINE COLLECTION/TRANSFER (SHUTTLE)
CONCEPT USAGE
                                                          THERMAL RESHITS
                                                                             ELEC PHR REGHTS MT/VOL REGHTS DEVELOPMENT RESUPPLY
  NO. TIME
                         ANT.
                                                                               PK PHR AVG PHR
                 TYPE USED
                                   ___ AC ____
       USES/DAY
                                                                                         AC
                                                                                                WEIGHT VOLUME AVAIL INDEX WEIGHT
                 ( ) -KG/USE-
                                                                               DĊ
                                                                                      DC
                                                                                                -KG- -CU H- (**) (***)
                                                                                                                                -KG+.
                       (LB/USE)
                                         (PS[G] (DEG F) (BTU/HR) (BTU/HR)
                                                                               -WATTS-
                                                                                                  (LBS) (CU FT)
       _28.000_
                        _.0000 ___.7.44_
                                                  _21+1_
                                                               - O • ....
                                                                      _248....
                                                                               -226+0 ----114+0--
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                                                               0.) ( 846.)
                                                                                 18.0
                                                                                         18.0 [ 58].1) [ 8.67]
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                        -- 3629 ---- 87.09 -
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                         .1497 36.29
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                                                                               226.0 __114.0 __112.5_
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                        _.1497 __36.29 _
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                       .3300) ( 80.00) ( .0) ( 90.0)
        28,000
                         .0000 9.44
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                                                                                        110.0
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                                         1 .01 [ 70.0]
                                                               0.1 (781.)
                                                                                10.0 10.0 ( 238.6) (
                        .1497 36.29
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                     1 .747011
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                                  .771 (
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                                                                        0:1
                                                                                   . .
APPLIANCE
CONCEPT
                                                                    (CIRCULATED), LITERS/SEC (FT3/MIN)
                                                                                                                                 (***)COST
                                                   1 - CABIN AIR
  NO.
             CONCEPT
                                                    2 - CABIN AIR
                                                                    (LOST)
                                                                             , KG/HR
                                                                                          (L9/HR)
                                                                                                       (**)AVAILABLE
                                                                                                                                    INDICATOR
          STANDUP URINAL
                                                                   (LOST) , KG/HR
(CIRCULATED), KG/HR
                                                    3 - OXYGEN
                                                                                          (LB/HR)
                                                                                                                                     0~25%
                                                                                                   (1) AVAILABLE
           COMMODE URINAL
                                                    4 - COOLING WATER
                                                                                          (LB/HR)
           INTIMATE HALE ADAFTER (SKYLAB)
                                                                    (LOST) , KG/HR
(CIRCULATED), KG/HR
                                                                                                                                     25-50%
                                                                                                   (2) STATE OF THE ART
                                                   5 - WATER
                                                                                          (LB/HR)
           APERTURE URINAL
                                                   6 - NITROGEN
7 - NITROGEN
                                                                                          (LB/HR)
                                                                                                   (3) SOME DEVELOPMENT REQUIRED
                                                                                                                                     50-75%
                                                                   (USED) , KG/HR
(CIRCULATED), KG/HR
(PROCESSED)
          LIQUID/GAS FLOW CUFF TYPE (APOLLO)
                                                                                          (LB/HR)
                                                                                                   (4) EXTENSIVE DEV. REQUIRED
                                                                                                                                     75-100%
                                                    8 - FREO!
                                                                                          (LB/HR)
                                                                    (PROCESSED) , KG/HR
                                                   9 - WATER
                                                                                          (LB/HR)
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D2:118561-

## 02-118561-2



Urine Collection/Transfer (Shuttle) Concept Trade

NUMBER OF DAYS - 20.5 ( .06 YEARS) USES HOD SUBROUTINE 27 THERMAL PENALTY - DIRECT TO COOLANT (18/8TUH) .0250 THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) - 0550 POWER PENALTY (LBS/WATT) TYPE 1 .5300 POWER PENALTY (LBS/WATT) TYPE 2 .4300 SELECTION MATRIX . . . . . . URINE COLLECTION/TRANSFER (SHUTTLE) 101/19/751 FACTOR VALUE VALUE 3 WEIGHT 238.62 581 - 10 15 7 . 69 .00 8.60 8 . 84 . 68 POWER .00000 127.52 .00 ..... 00 _.00 _1.09_ _15.00 VOLUME 1.7900 17.500 10 5.05 .00 8.98 8 . 20 .46.530. 15 . • 00 .. 1 - 15_ __1.15_ __1.15__15.00 RELIABAY .99976 5 1.00000 .03 .00 .00 - .44 MAINTENG .... 99999 1.00000 .02 ..... ...00__ DEV COST 10+000 50.000 15 .00 7 - 50 - 12 - 00 4 - 50 12 - 00 N _TOTAL_PI___.00000 -80.000 80. 5.10 16.34 30.73 24.50 60.79  $\overline{z}$ 100.00 100 6.38 20.42 38.41 30.63 75.99 50 1000

B2-161

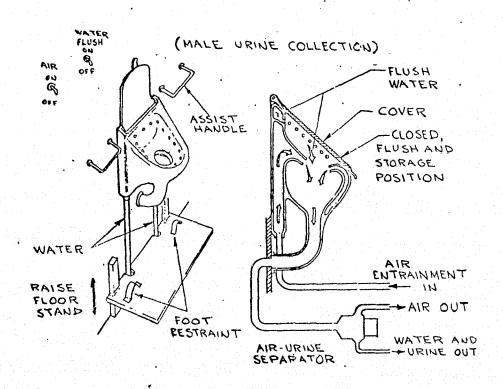
APPLIANCE FUNCTION: 2.1.2-URINE COLLECTION/TRANSFER

		· · · · · · · · · · · · · · · · · · ·		N L	J M B	E R	0	F	СО	мРС	NE	NTS	· · · · · ·		·		•
COMPONENT TYPE														<u>.</u>			NUMBER
	WATER SEPARATOR	URINE PUMP	SOLENOID VALVES	FILTER	CHE <b>CK</b> VALVE	CONTROLLER	REGULATOR	MOTOR.									OF SAFETY CRITICAL
APPLIANCE TYPE NO.	6	2	3	9	22)	19	1	1	0	0	0	0	0	0	0	0	ITEMS
STANDUP URINAL O NO VENTING	1	1	3	2	2	1	1	2							•		0
COMMODE URINAL O NO VENTING	1	1	3	3	2	1	1	2		:		٠					0
INTIMATE MALE ADAPTER URINAL (SKYLAB)  O NO VENTING	1	1	3	3	2	1	1	2									0
APERTURE URINAL O NO VENTING	1	1	1	3	-	1	1	2									0
LIQUID/GAS FLOW CUFF TYPE (APOLLO)	-	-	-	1	-	-	-	-									0
O VENTED OVERBOARD						•			•								
							•										
						•											
						•				• ,	•						•

SPACECRAFT_	Shuttle	•	Waste Collection/
HABITABILITY	SUBSYSTEM Personal Hygiene	_HABITABILITY FUNCTION	
APPLIANCE FL	NCTION Urine Collection,	/Transfer	
APPLIANCE CO	NCEPT NO./TITLE 1/Standup	Urinal	
INDEX NO	2.1.2.1	REF. NO. 209, 273, 2	07

#### DESCRIPTION

The standup urinal concept consists of a collector utilizing air entrainment for collection and transport of the urine and centrifugal separation of the air/urine. The cabin air used for entrainment is filtered and recirculated back into the cabin. The unit is mounted on the wall of the spacecraft. The unit is activated by opening the cover. After use, the cover is closed; a fixed quantity of flush water is used to flush the urinal. The unit automatically shuts down after the flush is completed. The total operating time was assumed to be one minute using 45 seconds as an average urination time. The flush water assumed used per cycle was 0.8 pound and was heated to 90°F. A pretreatment chemical was added to the flush water.



CONCEPT 1/STANDUP	KLEKE V ( ) dur	•	e eta e			NUMBER 2	
•	ELECIR	•	POWER	REQUIRE			
e de la companya de l	USE TIME	A	· · · · · · · · · · · · · · · · · · ·	R (4) DEMAND	<u> </u>	<u> </u>	V E R DEN/
	CYCLE	PEAK .	3 AVERAGE	(WATT-HR/ CYCLE)	PEAK	AVERAGE	(WATT
COMPONENT (REF)	(HR)	(WATTS)	(WATTS)	⊙x⊙	(WATTS)	(WATTS)	① X
ALETANSOMMONIA	20).0/25	200	100	1.25			سید سیست حصف
	MONITATARY				16	16	
MOTOR VILLE	MONTHNIACK		4		2	2	.0
CONTROLLES/THESE	_017_	:		``			<u> </u>
<del></del>	•	•		•			- :-
		226		1.37	18	•	0
		MAXIMUM		TOTAL	MUMIXAM		TOT
		• "		· · · · · · · · · · · · · · · · · · ·			
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••	• • • • • • • • • • • • • • • • • • •	•				•	
•	<u>-</u>			•	• • • • • • • • • • • • • • • • • • •	•	
	_ 	HERMAL.	REQUI	REMENIS			
	_ <b>1</b> !	HERMAL,	SEN	SIBLE -	HEAT LEAK		
SOURCE			SEN	* * *****	HEAT LEAK (BTU/HR)		TO COOLANT
		LATENT	SEN (BT	SIBLE -		• • • • • • • • • • • • • • • • • • •	
SOURCE MOTOPS (FINESCE) FUSH WATER C	<u> </u>	LATENT (BTU/HR)	SEN (BT	SIBLE U/HR)	(BTU/HR)		
MOTOPS (FINGS)	<u> </u>	LATENT (BTU/HR)	SEN (BT	SIBLE U/HR)	(BTU/HR)		(BTU/HR)  N/A  N/A
MOTOPS (FINESSE	<u> </u>	LATENT (BTU/HR)	SEN (BT	SIBLE U/HR)	(BTU/HR)		
MOTOPS (FINESSE	<u> </u>	LATENT (BTU/HR)	SEN (BT	SIBLE U/HR)	(BTU/HR)		(BTU/HR)  N/A  N/A
MOTOPS (FINESCE) FLUSH WATER C	<u>01.04</u> 10e)	LATENT (BTU/HR)	SEN (BT	SIBLE U/HR) 134 112	(BTU/HR)		(BTU/HR)  N/A  N/A
MOTOPS (FINESCE) FLUSH WATER C	ONPATOR)	LATENT (BTU/HR)	SEN (BT	SIBLE U/HR) 234 112	(BTU/HR) -734 -112		N/A N/A
MOTOPS (PANÉSE) FLUSH WATER C	ONPATOR)	LATENT (BTU/HR)  N/A  N/A	SEN (BT	SIBLE U/HR) 134 112 2(846)	(BTU/HR) -734 -112		(BTU/HR)  N/A  N/A
MOTOPS (FINESSE) FLUSH WATER C	ONPATOR)	LATENT (BTU/HR)  N/A  N/A	SEN (BT	SIBLE U/HR) 134 112 2(846)	(BTU/HR) -734 -112		(BTU/HR)  N/A  N/A
MOTOPS (FAMÉSE) FLUSH WATER C	ONPATOR)	LATENT (BTU/HR)  N/A  N/A	SEN (BT	SIBLE U/HR) 134 112 2(846)	(BTU/HR) -734 -112		(BTU/HR)  N/A  N/A
MOTOPS (FAMÉSE) FLUSH WATER C	ONPATOR)	LATENT (BTU/HR)  N/A  N/A	SEN (BT	SIBLE U/HR) 134 112 2(846)	(BTU/HR) -734 -112		(BTU/HR)  N/A  N/A
MOTOPS (FINESCI FLUSH WATER C	ONPATOR) COLLOCUM TOTAL	LATENT (BTU/HR)  N/A  N/A	SEN (BT 77 / / / / / / / / / / / / / / / / / /	SIBLE U/HR) 234 1/2 2(246) (BTU/HR)	(BTU/HR)  734  112  248 (S40  WATT (STU/HR)		(BTU/HR)  N/A  N/A
MOTOPS (FINESSE) FLUSH WATER C	OPPATOR)  COLLOCUM  TOTAL  OPP	LATENT (BTU/HR)  N/A  ATT (BTU/HR)  E R A I I O  THERMAL	SEN (BT 7 / / / / / / / / / / / / / / / / / /	SIBLE U/HR) 234 1/2 2(046) (BTU/HR)	(BTU/HR) -734 -112		(BTU/HR)
MOTOPS (FINESSE) FLUSH WATER C	ONPATOR) COLLOCUM TOTAL	LATENT (BTU/HR)  N/A  ATT (BTU/HR)  E R A T I O  THERMAL  THERMAL	SEN (BT 77 / / / / / / / / / / / / / / / / / /	SIBLE U/HR) 234 1/2 2(846) (BTU/HR)	(BTU/HR)  734  112  248 (840)  WATT (STU/HR)		(BTU/HR)  N/A  N/A
MOTOPS (FINESCE) ELUSH WATER C.  RIGINAL PAGE IS POOR QUALITY	ONPATOR)  COLDOUN  TOTAL  NO  HEAT L	LATENT (BTU/HR)  N/A  ATT (BTU/HR)  E R A T I O  THERMAL  THERMAL	SEN (BT / Z45) WATT  NAL PE	SIBLE U/HR)  234 1/2 2(246) (BTU/HR)  ELECTRICAL	(BTU/HR)  734  112  248 (840)  WATT (STU/HR)		(BTU/HR)  N/A  NATT (BTU/H

B2-164

WATTS/CYCLE (BTU/HR/CYCLE)

TOTAL

WATTS/CYCLE (BTU/HR/CYCLE)

KG/MISSION)

(£13/H122104) H3/H122104

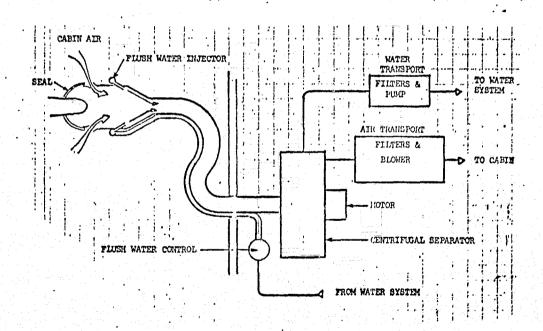
		REQUIREMENTS	AND	PENALTIES	CALCULATIONS					
CONCEPT 1/5TANDUP	URINAC	•				INDEX	NUMBER	2.	رحرا	

COMPONENT	(REF)	WEIGHT (LBS)	•	VOLUME (FT3)
	PONENTS (209) _	. 115	-	8.67
<del></del>			· · · · · · · · · · · · · · · · · · ·	<del></del>
				*
	TOTAL	52.2 (115)		25 (8.6
		· KG (LBS)	المستعددة	M ³ (FT ³ ) ,
IAL PAGE IS	<u>SOLID EXPENDABI</u>		QUIREMENTS	
OR QUAL	Alt MINIT			VOL/CYCL
TYPE	UNITS/CYCLE(REF) (LB)	IT)(REF) (1) X (2)	\( \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \	EF) ① X ④ (FT³)
N/A-				
				<del></del>
				_
		∑③	Σ	(5) TOTAL VOL/C
TOTAL WT. =		(LB)		(112)
CYCL	ES/DAY DAYS/MISSION	TOT.WT/CYCLE (LB)	I <del></del>	KG (LB)
TOTAL VOL =				
CYCL	ES/DAY DAYS/MISSION	TOT.VOL/CYCLE (FT3)	<del>-</del>	M ₃ (E1 ₃ )
	GAS/LIQUID EXPI	ENDABLES REC	UIREMENTS	
	Φ	② RECOVERY	MIT.RECOVERED/CYCLE	AMT LOST/CY
ТҮРЕ	AMT. USED/CYCLE(REF)	FACTOR	①x② (LB)	(1)-(3) (LB)
FLUSH WATER PRETREATMEN	· · · · · · · · · · · · · · · · · · ·	N/A	<i>N/A</i>	.8
CHEMICAL	.012 (209)	N/A	N/A ·	.012
		. <u> </u>		
	Σ08/2_		$\Sigma$ @	

SPACECRAFT	h + 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-1 / 1-		Waste Collection/
HABITABILI	TY SUBSYSTEM Personal Hygiene HABI	TABILITY FUNCTION	Transfer
APPLIANCE	FUNCTION Urine Collection/Trans	sfer	-
APPLIANCE	CONCEPT NO./TITLE · 2/Commode Uri	ina] ''	
INDEX NO.	2.1.2.2 REF	. NO. <u>207, 209, 2</u>	73

#### DESCRIPTION

The commode urinal concept consists of a urine collector, centrifugal separator, and flush unit. This unit would be used where combined feces and urine collectors are defined. The unit uses a flush as described in Concept 1; however, 0.33 pound per flush was used because of the smaller surface area requiring biocide treatment. Air entrainment is employed coupled with a properly directed urine stream. The operating time is the same as specified for Concept 1. Cabin air used for urine entrainment is filtered and returned to the cabin.



## 02-118561-2

## APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT 2/COMMONE URWAL

INDEX NUMBER 2-1,2-7

ELECI	RICAL P	OWER REQUIR		0 W E R
USE TIME  CYCLE  COMPONENT (REF) (HR)  AIRIFAH/SCPARATCL(20) .0125  URING PUMP .0125  SOLUNOID WALVES(2) MOMENIAR  MOTOR VALVE  CONTROLLES/TIMES07	② PEAK (WATTS) 200 15	(4)		6 DEMAN AGE (WATT) TS) ① X(2
	ZZ6 MAXIMUM  THERMAL	1.37 TOTAL  REQUIREMENIS	18 MAXIMUM	
SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
MOTORS (FANTSCENEAR) EUSH WATER COOLDOWN	N/A N/A		734	_ N/A _ N/A
TOTAL	O -	228.9 (7.00.6) WATT (BTU/HR)	228.9 (780.6) WATT (BTU/HR)	O HATT (BTU/HR
RIGINAL PAGE IS F POOR QUALITY				
	<u> </u>	NAL PENALTIE	<u>.</u>	ngagi nggal dat Ngganagan

	SOURCE	THERM HEAT LEAK (BTU/HR/CYCLE)	IAL" TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	'VOLUME (FT3/MISSION)
					•	
			•			<del></del>
<u>}</u>						
	TOTAL	WATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)		KG/MISSION (LB/MISSION)	M ³ /MISSION (FT ³ /MISSION)

B2-167

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT Z/COMMODE URINAC

INDEX NUMBER Z. 1. Z. Z-

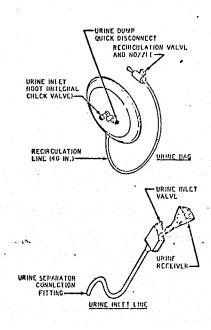
COMPONENT		(REF)	WEIGHT (LBS)		VOLUME (FT3)
URINAL /CE	DINPONENTS	<u>(207)</u>			7.5
		•			
AL PAGE E		TOTAL .	39.5 (8°	7)	.495 (A
OR QUALA	<u>\$ 0 L 1 D</u>	EXPENDAB		EQUIREMENT	
	U	(FRG-W170))	(1)(REF) $(1)(2)$	(PKG.VOL/UNIT)	(F) VOL/C (REF) ①X (FT)
N/A	UNITS/CYCL	LE(REF) (LB	) (LB)	(FT ³ )	
	<del>,</del>				<del></del>
		•			
	·		• • • • • • • • • • • • • • • • • • •		
**************************************	· · · · · · · · · · · · · · · · · · ·	•	∑3	CLE	TOTAL VO
TOTAL WT. =		<b>X</b>	(LB)		, (FT
	CYCLES/DAY	DAYS/MISSION	TOT.WT/CYCLE		KG (LB)
TOTAL VOL =	CYCLES/DAY	XDAYS/MISSION	XX	_ •	M ³ (FT ³ )
			(FT ³ )		
	<u>G A S/L 1</u>	<u> </u>	<u>ENDABLES</u> RE	QUIREMENTS	
	<b>A</b> A	① MT.USED/CYCLE(REF)	RECOVERY	AMT. RECOVERED/CYCLI  (LB)  N/A	AMT LOST
FLUSH WA		(LB) (207)	FACTOR N/A	N/A	. (LB
PRETREAT	MENT_	.7/2 (209)	N/A	N/A.	.01
	Σ ①	.342	1 <del></del>		① .342
	<b>&gt;</b> (11)	34/		- 15 m	(4) 274/

### D2-1185/1-2

SPACECRAFT	S	huttle			Waste Collection,
HABITABILI	TY SUBSYSTEM Person	al Hygiene	_HABITABILIT	Y FUNCTION	
APPLIANCE	FUNCTION Urine	Collection/	Transfer		
APPLIANCE	CONCEPT NO./TITLE_	3/Intimate	Male Adapte	r	
INDEX NO	2.1.2.3		_REF. NO	283, 250	

#### DESCRIPTION

The intimate male adapter concept consists of a wall-mounted unit similar to the unit used for the Skylab fecal/urine collector system. The adapter can be used when seated or in a standing position. Air entrainment is used to provide a substitute for gravity collection. The cabin air used for entrainment is filtered and recirculated back into the cabin. One wipe per cycle was assumed to be used because of splashback during urination. The flushing and operating time are the same as for Concepts 1 and 2. The flush water used was assumed to be 0.33 pound per flush. The second aperture unit pictured below uses an iris-type seal for the penis to prevent cabin contamination. The unit is designed to minimize spashback using a splash retarder. This unit operates the same as the Skylab unit.



### APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

INDEX NUMBER 2,12,3

	CONCEPT 3/JUT//NATC	MALE A	DAPTUR			INDEX	NUMBER	1:6-1-3
•		ELEC 1	•		REQUIRE			r n
		0	A C	, POWE	(4)	0.0		E K (7)
٠.		USE TIME	<b>②</b>	3	DEMÁND (WATT-HR/	<u>(5)</u>	<b>(6)</b>	(7) DEMANG (WATT-HE
•	COMPONENT (REF)	CYCĽE (HR)	PEAK (WATTS)	AVERAGE (WATTS)	CYCLE)  ① X ③	PEAK (WATTS)	AVERAGE (WATTS)	CYCLE) ① X ⑦
		•	200		•	(##113)	· (#D112)	₩.C
	ALL FANISCPARATOR (20)	).0175 -0125	15	100	1.25			
	SOLENOID VENEYE)		4			16	16	
•	MOTOR VILLE			4	,		-	,
	CONTROLLER/THREE	.07		٠ ـــــ		<u>z</u>	<u> </u>	03
N.	· · · · · · · · · · · · · · · · · · ·						······································	<del></del>
	######################################	<del></del>	•					
								· <del> </del>
		•	226		1.37	18	•	.03
	•		MAXINUM .	• .	TOTAL	MAXIMUM		TOTAL
			•	•	•			
		•			•			
		•					•	-
•	•		•		•			
	•		IHERMAL,	REQUIF	REMENTS		•	
•		•	4.0	<b>6</b> 5414		11545 1 54V		70. 6001 1117
	equiper		LATENT (BTU/HR)	•	SIBLE J/HR)	HEAT LEAK (BTU/HR)	1	O COOLANT
	SOURCE		(Blo/nk)	(Bit	)/ IIIV.)	(Droymky		2010/11/7
	MOTORS (FANS ESET	PARATOR)	N/A.		34	_734		NA
	FLUSH WATER COL		NIA		46.6	46.6	· · · · · · · · · · · · · · · · · · ·	NA
							•	
		• •		<del></del>			<del>-</del>	-
		<del></del>						
		<del>.</del>					_ `_	
		TOTAL	0	2289	(780.6)	223.9 (7.8	06)	0
		TOTAL	WATT (BTU/HR)		(BTU/HR)	WATT (BTU/HR)		ATT (BTU/HR)
			with (bio)in		(Βιογιπί)	HATT (BEO/IIK)	W/	vii (bin)nk)
<b>ORIGI</b>	NAL PAGE IS		•	•	• •	•	•	
OF PO	OR QUALITY	• • •						•
	OIL QUALITY							
					•			
			<u>DPERATION</u>	AL PE	NALIIES			
			THERMAL		•			
		HEA.	T LEAK TO	COOLANT	ELECTRICAL			VOLUME
	SOURCE	(BTU/HR	/CYCLE) (BTU	/HR/CYCLE)	(PK WATTS/CY	CLE) (LB/MISS	(ON)	EL3/WI22IOM)
	-N/A-		•					•
				<del></del> -				<del></del>
				<del> </del>	·			
•		<del></del>		<del></del>		· ·		
							<u> </u>	<del></del>

B2-170

WATTS/CYCLE (BTU/HR/CYCLL) KG/MISSION (LB/MISSION) M3/M1SSION (FT3/M1SSION)

TOTAL

WAITS/CYCLE (BTU/HR/CYCLE)

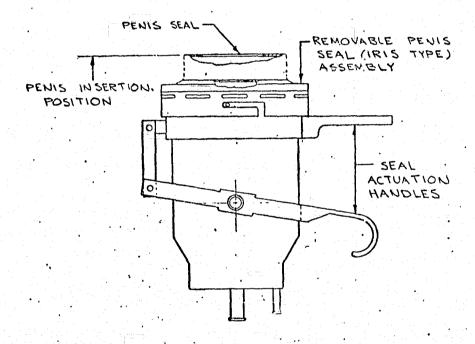
# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED) CONCEPT 3/INTIMATE NIALE NORPTER INDEX NUMBER 2-1-2-3

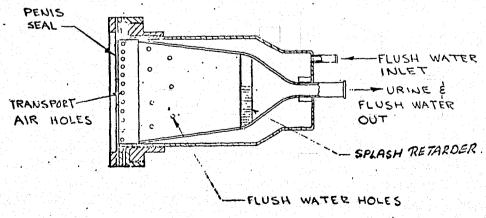
COMPONENT	(REF)	WEIGHT (LBS)		VOLUME (FT ³ )
URINAL	The statement of the st	2.8		0058
COMPONENTS DRY WIPES	(250)	40.0		568
vici wires				
			•	
			· · · · · · · · · · · · · · · · · · ·	
	****	02 - (-17)		<u> </u>
IAL PAGE IS	TOTAL	23.5 (51.7)	.05	
OR QUALTINE		. KG (LBS)		M3 (FT3)
<u>8 0 F</u>	<u>ID EXPENDABL</u>	E WI/VOL RE	QUIREMENIS	•
	2	3	4)	(S)
	WT/UNIT ( PKG.WT/UNI	T)(REF) (DX(2)	VOL/UNIT (REF) (PKG.VOL/UNIT)(REF	VOL/CYC (FT ³ )
DRY WIPES UNIT	S/CYCLE(REF) (LB) / 2.04/190		(FT3) 129/196 (250	0)0000
,	1 201/17	26 .00026		NE
APERTURE SUMS			**************************************	
				. <del> </del>
-		Σ3 .01066	Σ	2000
	•	∑ ③	E	OOO TOTAL VOL/ (FT ³ )
TOTAL WT.				
MISSION FOR THE PROPERTY OF TH	X ZOS DAYS/MISSION	xx	• 4.	Z' (9 KG (LB)
		(LB)		
TOTAL VOL = 42	x20,5	x .00066		016 (05
CYCLES/DAY	DAYS/MISSION	TOT.VOL/CYCLE (FT3)		M3 (£13)
en e	<u> S/LIQUID EXPE</u>	NDABLES REQ	UIREMENTS	
				. @
	① AMT.USED/CYCLE(REF)	RECOVERY	AMT.RECOVERED/CYCLE	AMT LOST/O
TYPE	(LB)	FACTOR	①x② (LB)	, ①-③ (LB)
FLUSH WATER	33 (207)	N/A	N/A	<i>.3</i> 3
PRETREATMENT	112/2091	N/A	KI/D	.012
CHEMICAL				
	•			
$oldsymbol{\Sigma}_{0}$	①34Z		$\sum \Phi$	
		en i <u>l</u> deservation de la compa		

SPACECRAFT_	Shuttle		0.77
HABITABILITY	SUBSYSTEM Personal Hygiene HABITABIL	ITY FUNCTION	Waste Collection, Transfer
APPLIANCE FU	NCTION Urine Collection/Transfer		
APPLIANCE CO	NCEPT NO./TITLE 4/Aperture Urinal		
INDEX NO	2.1.2.4 REF. NO.	236, 273,	209, 207

#### DESCRIPTION

The aperture urinal concept consists of an aperture and centrifugal separator. Urine is collected as described in the previous concepts. The study assumed 0.33 pound of flush water per cycle. The operating time is the same as Concepts 1 through 3.





CONCEPT 4/NPERTURE URINAL

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

INDEX NUMBER 2.1.2 A

Ē	L	Ē	<u>C</u>	Ţ	<u>R</u>	1	Ċ	A	Ī	•	<u>P</u>	0	Ä	E	R		R	E	Q	U	<u>I</u>	R	Ē	M	Ē	N	Ţ	<u>S</u>
									٠.		_				_	 -	•											

	ELECT	SICVE :	POWER .	REQUIRE	MENIS		•
•	, ,	· A (	POWE		D	C PONE	
COMPONENT (REF)	USE TIME  CYCL'E  (HR)	PEAK (WATTS)	(WATTS)	DEMAND (WATT-HR/ CYCLE) ① X ③	⑤ PEAK (WATTS)	AVERAGE (WATTS)	(7) DEMAND (WATT-HR/ CYCLE) ① X ⑦
AIR FAN/SUMMENS WEINE PROPE SOLENOIS VALVE	<u>-0125</u> Momonine	200 15	100	1.25	=======================================		034
CONTROLLER / TEME	2 _017						
	•	2/5 MAXIMUM .		1.37 TOTAL		•	
	•		•				
	. 1	HERMAL.	<u>REQUII</u>	REMENIS			for a second of the second of

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
MOTORS (FAMÉSCAMATOR) ELUSH WATER	N/A N/A	<u>734</u> <u>46.6</u>	734 46.6	N/A
			Action .	•
TOTAL	O	228.0° (780.6) WATT (BTU/HR)	228.9 (780.6) WATT (BTU/HR)	O WATT (BTU/HR)

## OPERATIONAL

SOURCE	HEAT LEAK (BTU/HR/CYCLE)	RMAL* TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT ³ /MISSION)
-N/A-					
	<u> </u>				
707					
	WATTS/CYCLE	WATTS/CYCLE		KG/MISSION	M3/MISSION

## D2-113561-2

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 4/INTIMATE URINAL

INDEX NUMBER 2.1.2.4

• • •	XED HEIGHT/Y	WEIGHT	<u>IREMENIS</u>	VOLUME (FT ³ )
MPONENT VEINING /EOMIPONENI	(REF) 5 (236)	(LBS) 42.3		3.15
· · · · · · · · · · · · · · · · · · ·				
	•		<del></del>	
		• • Est. :		<del></del>
	TOTAL	356.3 (42.3	3) .0	3.15)
		KG (LBS)		M3 (FT3)
, <u>soli</u>	D EXPENDABL	E WT/VOL R	<u>EQUIREMENTS</u>	
<u> </u>				OL/CYCLE
TVDE INSTE	O WT/UNIT (F	(REF) (1) x (2)	VOL/UNIT (REF) (PKG.VOL/UNIT)(RE	VOL/CYCLE EF) ①x.④
TYPE UNITS/	CYCLE(REF) (LB)	(LB)	(FT ³ )	(FT3)
		•		
		TOTAL WT/CYC	$\sum_{i}$	TOTAL VOL/CYCLE
en e		(LB)		(FT ³ )
OTAL WT.	XX	XX	•	
CYCLES/DAY	DAYS/MISSION	TOT.WT/CYCLE (LB)		KG (LB)
DTAL VOL =	<b>x</b>	<b>X</b>		
CYCLES/DAY	DAYS/MISSION	727.VOL/CYCLE (FT3)		M ₃ (F1 ₃ )
<u>G A S</u>	<u>LIQUID EXPE</u>	NDABLES RE	QUIREMENTS	
	<b>0</b>	0	MT.RECOVERED/CYCLE	•
	AMT. USED/CYCLE (REF)	RECOVERY	(1) X (2)	AMT LOST/CYCLE  O-3  (LB)
TYPE FLUSH WATTER	. 33 (207)	FACTOR	(LB)	(LB)
PRETREATMENT				
CHEMICAL	012(209)	<i>N/A</i>	N/A ·	012
. $\Sigma$ $_{f 0}$	342		$\Sigma$	342
OTAL HT 28				89 (196.3)

### 02-118561-2

SPACECRAFT	Shuttle		
HABITABILITY SUBSYSTE	M Personal Hygien	e HABITABILITY FUNCTION	Waste Collection/ N_Transfer
APPLIANCE FUNCTION	Urine Collection	/Transfer	
APPLIANCE CONCEPT NO.	/TITLE 5/Liquid	/Gas Flow Cuff-Type (Apo	0110)
INDEX NO. 2.1.2.5		REF. NO. Rockwell Dw	g. SEB14000010-303
DESCRIPTION			

DESCRIPTION

The liquid/gas flow cuff-type concept is the system used on Apollo. A cuff is utilized which fits snuggly to the penis. Urine transfer was accommodated on Apollo using a vacuum; however, a centrifugal separator could also be utilized. The concept presented assumes vacuum transfer since the intimate male adapter (Concept 3) is similar and uses air entrainment. The operating time was assumed to be 1.75 minute using a 45 second urination time. Filter change was considered for this concept due to the frequent changeout required (one per 14.3 man-days).

> FLEXIBLE BOOT RECIRCULATION LINE CONNECTION (CONNECTS TO RECIRCULATION LINE NOZZLE)

SPACECRAFT	Shuttle			
HABITABILITY SUBSYSTE	EM <u>Personal Hygie</u>	ne HABITABILITY		te Collection/ nsfer
APPLIANCE FUNCTION_	Urine Collectio	n/Transfer .		
APPLIANCE CONCEPT NO.	./TITLE5/Liqui	d/Gas Flow Cuff-T	Type (Apollo)	
INDEX NO. 2.1.2.5		REF. NO. Rock	kwell Dwg. SE	B14000010-303
DESCRIPTION				

The liquid/gas flow cuff-type concept is the system used on Apollo. A cuff is utilized which fits snuggly to the penis. Urine transfer was accommodated on Apollo using a vacuum; however, a centrifugal separator could also be utilized. The concept presented assumes vacuum transfer since the intimate male adapter (Concept 3) is similar and uses air entrainment. The operating time was assumed to be 1.75 minute using a 45 second urination time. Filter change was considered for this concept due to the frequent changeout required (one per 14.3 man-days).

RECIRCULATION LINE
CONNECTION (CONNECTS
TO RECIRCULATION
LINE NOZZLE)

CONCEPT 3 FLEDOTO	GAS FLO	m CUFF	TYPE (F	PENALTIES CALCU	INDEX HUP	BER Z.1. Z. 5
in in the second of the secon	ELECT	RICAL	<u>P Q W E R</u>	R E Q U 1 R E		• • •
	0	ΑΑ	C . POWE	R (4)	D_C	POWER (7)
•	USE TIME	2	3	DEMAND	(5)	(7) (6) DEMAND AVERAGE (WATT-HR
	CYCLE	PEAK	AVERAGE	(WATT-HR/ CYCLE)		CACLE)
COMPONENT (REF)	(HR)	(WATTS)	(WATTS)	① x ③	(WATTS)	(WATTS) ①X①
· N/s.						
			<del></del>			
			****			<del></del>
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			-			<u> </u>
	• • • • • • • • • • • • • • • • • • • •					and the second of the
•		444 / \$131.114		TOTAL	MAXIMUM	TOTAL
		MAXIMUM		TOTAL	MAXIMUM	IVIAL
	•		•			
			•	•	•	
			•			
	•	THERMAL	REQUI	REMENTS		
					•	
		LATENT	SEN	SIBLE	HEAT LEAK	TO COOLANT
SOURCE		(BTU/HR)	(BT	U/HR)	(BTU/HR)	(BTU/HR)
N/A						
	<u> </u>					
			_	<del></del>		
	<del></del>		-	<del></del>		
			<u>.</u>			
	. 1194 + 114 <u>1</u> 		<u> </u>			
	TOTAL		<del>حدودتی</del> و دان	<u> </u>		
		WATT (BTU/HR)	WATT	(BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)
	2	<u> </u>	<u>NAL PE</u>	NALTIES		
		THERMAL		er cerpresi	WEIGHT	VOLUME
	HEAT (BTU/HR)	LEAK	TO COOLANT TU/HR/CYCLE)	ELECTRICAL  (PK WATTS/CYC		
COUNCE.	(B)U/NK/	CICLE)	io/inv/croce/	(1) (1) (1)		
SOURCE	The Armide Control of the Control					
SOURCE ·						
	TOTAL	S/CYCI.E	WATTS/CYCLE		KG/M1SS10/	M3/M1SS10N

B2-176

## APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED) CONCEPT 5/ (19010/GAS FLOW CUFF TYPE (19010) INDEX NUMBER 2.1.2.5

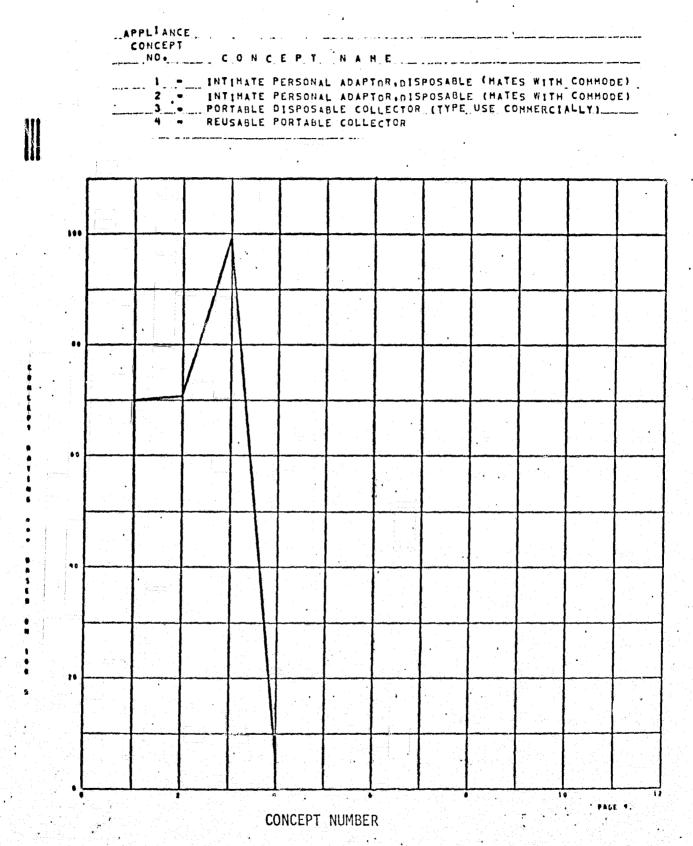
TOTAL SOME (ILII)  TOTAL SOME (ILII)  SOLID EXPENDABLE NIVOL REQUIREMENTS  TYPE UNITS/CVCLE(REF)  STORY  42  CYCLES/DAY X DAYS/RISSION X TOT. HY/CYCLE (HS)  STORY  42  CYCLES/DAY X DAYS/RISSION X TOT. HY/CYCLE (HS)  STORY  42  CYCLES/DAY X DAYS/RISSION X TOT. HY/CYCLE (HS)  STORY  42  CYCLES/DAY X DAYS/RISSION X TOT. HY/CYCLE (HS)  STORY  42  CYCLES/DAY X DAYS/RISSION X TOT. HY/CYCLE (HS)  STORY  42  CYCLES/DAY X DAYS/RISSION X TOT. HY/CYCLE (HS)  STORY  42  CYCLES/DAY X DAYS/RISSION X TOT. HY/CYCLE (HS)  STORY  43  CYCLES/DAY X DAYS/RISSION X TOT. HY/CYCLE (HS)  STORY  44  CYCLES/DAY X DAYS/RISSION X TOT. HY/CYCLE (HS)  STORY  45  CYCLES/DAY X DAYS/RISSION X TOT. HY/CYCLE (HS)  STORY  47  CYCLES/DAY X DAYS/RISSION X TOT. HY/CYCLE (HS)  STORY  47  CYCLES/DAY X DAYS/RISSION X TOT. HY/CYCLE (HS)  STORY  47  CYCLES/DAY X DAYS/RISSION X TOT. HY/CYCLE (HS)  ANT. USED/CYCLE (REF)  FACTOR  FACT		FIXED	WEIGHT/	VOLUME RE	Q <u>U I R E M E N I</u>	<u>s</u>	
TOTAL S.O. (1/11)	MPONENT	_ '	EF)	(LBS)			
TOTAL			engang 1 to 100 militaria. Tanàna	-6		2	54
TOTAL    SOLID   EXPENDABLE   MJ/YOL   REQUIREMENTS   WOLVERT (REF)   VOLVETCLE   VOLVETCL				.7/		3	6
TOTAL    S.O.4 (11.11)   .09 (3.17)	MCKAGING &	URINE HE	56	5.0		1.0.	35
TOTAL    S.O.4 (11.11)   .09 (3.17)		<del></del>			•		
TOTAL    S.O.4 (11.11)   .09 (3.17)		· · · · · · · · · · · · · · · · · · ·	<u>.</u>				
TOTAL    S.O.4 (11.11)   .09 (3.17)	<del> </del>	<del></del>	<del></del>		<del></del>		
TOTAL    S.O.4 (11.11)   .09 (3.17)			<del></del> . : <del></del>		<del></del>		
TOTAL    SOLID   EXPENDABLE   NI/YOL   REQUIREMENTS   NOL/YELE   N							
SOLID EXPENDABLE NIVOL REQUIREMENTS  ONTOWING (REF) (PKS. MT/UNIT) (REF) (PKS. MT/UNIT) (REF) (PKS. MT/UNIT) (REF) (LB) (LB) (LB) (LB) (LB) (LB) (LB) (LB							
SOLID EXPENDABLE NIVOL REQUIREMENTS  ONTOWING (REF) (PKS. MT/UNIT) (REF) (PKS. MT/UNIT) (REF) (PKS. MT/UNIT) (REF) (LB) (LB) (LB) (LB) (LB) (LB) (LB) (LB		<b> </b>	OTAL .	5.04 (11	(.//)	.09	(3.17)
### ##################################			•				T ³ )
### ##################################				•			
TYPE UNITS/CYCLE(REF) (LB) (LB) (LB) (LB) (LB) (LB) (LB) (LB		SOLID B	XPENDABL				, ,
TYPE UNITS/CYCLE(REF) (LB) (LB) (LB) (LB) (LB) (LB) (LB) (LB		•	WT/UNIT (I	RĒF) WT/CŸ	) CLE VOL/UN	(4) LT (REF)	(5) VOL/CYCLE
Description	TVDE		(PKG.WT/UNI	T)(REF) (1)X(	(PKG.VOL,	/UNIT)(REF)	① X ④
$\sum \Im \underbrace{-2023}_{\text{TOTAL WIT/CYCLE}} \qquad \sum \Im \underbrace{-2037}_{\text{TOTAL WIT/CYCLE}} $ $\sum \operatorname{STON} = \underbrace{42}_{\text{CYCLES/DAY}} \times \underbrace{20.5}_{\text{DAYS/MISSION}} \times \underbrace{-324}_{\text{KG (LB)}} $ $\sum \operatorname{CYCLES/DAY} \times \underbrace{20.5}_{\text{CYCLES/DAY}} \times \underbrace{-20.5}_{\text{DAYS/MISSION}} \times \underbrace{-0042}_{\text{TOT.WIT/CYCLE}} $ $\sum \operatorname{CYCLES/DAY} \times \underbrace{-0042}_{\text{CYCLES/DAY}} \times \underbrace{-07}_{\text{DAYS/MISSION}} \times \underbrace{-07}_{\text{TOT.WIT/CYCLE}} $ $\sum \operatorname{AMT.USED/CYCLE} (\operatorname{REF}) \times \underbrace{-07}_{\text{RECAVERY}} \times \underbrace{-07}_{\text{CYCLE}} \times -0$					22 2	5	
TOTAL (HE)CYCLE							
TOTAL (HE)CYCLE	<del></del>			<del></del>	<del></del>		
TOTAL WIT/CYCLE   TOTAL WIT/			<del></del>		<del></del>	<del> </del>	· · · · · · · · · · · · · · · · · · ·
TOTAL (HE)CYCLE							
TOTAL (HE)CYCLE	<del></del>			<del></del>			
TOTAL (HE)CYCLE							
$\frac{L \text{ WT.}}{S \text{ SION}} = \underbrace{\frac{42}{\text{CYCLES/DAY}}}_{\text{CYCLES/DAY}} \times \underbrace{\frac{20.5}{\text{DAYS/MISSION}}}_{\text{DAYS/MISSION}} \times \underbrace{\frac{324}{\text{TOT.WT/CYCLE}}}_{\text{(LB)}} \times \underbrace{\frac{324}{\text{KG (LB)}}}_{\text{KG (LB)}} \times \underbrace{\frac{324}{\text{CYCLES/DAY}}}_{\text{KG (LB)}} \times \underbrace{\frac{324}{\text{CYCLES/DAY}}}_{\text{M3 (FT3)}} \times \underbrace{\frac{324}{\text{CYCLES/DAY}}}_{\text$		1. <b>₹</b> .		<b>\( \)</b> 3 _ <u> </u>	70YCI F	· Σ ⑤	00042
$\frac{\text{CYCLES/DAY}}{\text{SSION}} = \frac{42}{\text{CYCLES/DAY}} \times \frac{20.5}{\text{DAYS/MISSION}} \times \frac{\text{DOU4Z}}{\text{TOT.VOL/CYCLE}} \times \frac{0004Z}{\text{(FT}^3)} \times \frac{0004Z}{\text{TOT.VOL/CYCLE}} \times \frac{0004Z}{\text{(FT}^3)} \times \frac{0004Z}{\text{CYCLES/DAY}} \times \frac{0004Z}{\text{DAYS/MISSION}} \times \frac{0004Z}{\text{TOT.VOL/CYCLE}} \times \frac{0004Z}{\text{(FT}^3)} \times \frac{0004Z}{\text{(FT}^3$						, , ,	(FT ³ )
$\frac{\text{CYCLES/DAY}}{\text{SSION}} = \frac{42}{\text{CYCLES/DAY}} \times \frac{20.5}{\text{DAYS/MISSION}} \times \frac{\text{DOU4Z}}{\text{TOT.VOL/CYCLE}} \times \frac{0004Z}{\text{(FT}^3)} \times \frac{0004Z}{\text{TOT.VOL/CYCLE}} \times \frac{0004Z}{\text{(FT}^3)} \times \frac{0004Z}{\text{CYCLES/DAY}} \times \frac{0004Z}{\text{DAYS/MISSION}} \times \frac{0004Z}{\text{TOT.VOL/CYCLE}} \times \frac{0004Z}{\text{(FT}^3)} \times \frac{0004Z}{\text{(FT}^3$	TAL WT. = 47	2 _Y	20.5	x .0009	33 • 1	.324	(71)
$\frac{\text{L VOL}}{\text{SSION}} = \frac{42}{\text{CYCLES/DAY}} \times \frac{20.5}{\text{DAYS/MISSION}} \times \frac{00042}{\text{TOT.VOL/CYCLE}} = \frac{001}{\text{M}^3 \text{ (FT}^3)} \times \frac{30}{\text{M}^3 \text{ (FT}^3)$	CÝCLE	S/DAY	DAYS/MISSION	TOT.WT/CYC		KĠ (L	B)(**/)
CYCLES/DAY  DAYS/MISSION  TOT.VOL/CYCLE (FT3)  GAS/LIQUID  EXPENDABLES  REQUIREMENTS  AMT.USED/CYCLE(REF)  AMT.USED/CYCLE(REF) (LB)  FACTOR (LB)  AMT.USED/CYCLE(REF)  (LB)  AMT.USED/CYCLE(REF)  AMT.USED/CYCLE(REF)  AMT.USED/CYCLE  AMT.USE	ے مد At vol						
GAS/LIQUID EXPENDABLES REQUIREMENTS  AMT.USED/CYCLE(REF)  TYPE  (LB)  FACTOR  (LB)  FACTOR  (LB)  FACTOR  (LB)  1947	IISSION = 42	Z X	20,5			.0/	(.36)
Type $(LB)$ Factor $(LB)$ $(L$	CTULE	.5/UA1	DW SYMISSION	(FT ³ )	CLE	w./t	1.7
Type $(LB)$ Factor $(LB)$ $(L$							
Type $(LB)$ Factor $(LB)$ $(L$		CAS/ITOI	IIN FYPE	NDARIES	REDUTREME!	, N T S	
TYPE (LB) FACTOR (LB) (LB) $\chi \chi G \in \mathcal{N}$ (LB		505577					•
TYPE (LB) FACTOR (LB) (LB) (LB) $\chi \gamma G \in \mathcal{N}$ $947$ $M/A$ $M/A$ $947$ $\Sigma \odot 947$ $\Sigma \odot 947$					AMT . RECOVERED	CYCLE AMT	LOST CYCLE
Σ • 947 N/A N/A .947  Σ • 947  Σ • 947	TYPE	AMT.US	SED/CYCLE(REF) (LB)		UX(2) (LB)		(LB)
Σ①947 Σ④947	XYGEN				N/A_		947
Σ①947 Σ④947							
Σ①947 Σ④947		<del></del>				<u>.                                    </u>	
					<del></del>		
		<u> </u>	017		<del> </del>	50 0	17
L WT 28 x Zo.5 x .947 - 543.6 + MA - 246.6 (543		20	771			40 -21	T/
STON - 28 x CO.S x 947 - 543.6 + 144 - 246.6 (543	AI WT.					/ 127	11/
	SS1011 *	XX		.947 ·	543.6 + 14	19 - 29	6.6 (545)

HABITABILITY SUBSYSTEM_	2.0	Personal Hygiene
HABITABILITY FUNCTION_	2.1	Waste Collection/Transfer
APPLIANCE FUNCTION 2	.1.3	Vomitus Collection/Transfer
NUMBER OF CONCEPTS CONS	IDERE	D4

#### **ASSUMPTIONS**

- (1) The vomites collection/transfer concept considered portable and fixed methods. The collection devices used in conjunction with the fecal collector or waste disposal unit were considered fixed. The fixed method is not the most ideal since a sick crewman may not always be able to reach the collection device prior to vomiting. Fixed methods, however, were considered for the purpose of comparison.
- (2) The study assumed .84 cycles per day for Space Station and .56 cycles per day for Shuttle. The concept use time required per cycle is dependent on the concept type.
- (3) Filter weight and volume were included if a high replacement frequency is required. Periodic filter replacement was not included in the study.
- (4) Flush water, if required, for a vomitus collection concept was assumed not recoverable since the used flush water would normally be dumped into the fecal collector.

INDEX NO. 2-1-3 **** VOMITUS COLLECTION/TRANSFER (SHUTTLE)	,
CONCEPT USAGE CONSUMABLES AND FLOW REQUIREMENTS THERMAL NO. TIME	REGHTS ELEC PWR REGHTS WT/VOL REGHTS DEVELOPHENT RESUPPLY
AMT. USES/DAY TYPE USED FLOW PRESS TEMP COOLANT	PK PWR AVG PWR HT LEAK AC AC WEIGHT VOLUSE AVAIL INDEX WEIGHT
HRS/USE (*) +KG/USE- • +MHHGDEG C- +WATTS- (LB/USE) (*) (PSIG) (DEG F) (STU/HR) (	-WATTSDCCU H- [00] [000] -KG-
***************************************	
1 .5 ⁶ 0 1 .0000 9.44 .0 21.1 0.	00 .0 .6 .01 & 25 .0
•0:6(0000)(_20.00)_(00)_(_70.0)_(0.)	Constitution of the Consti
2 •560 1 •0000 7,49 •0 21+1 0• •016 ( •0000)( 20•00) ( •0) ( 70•0) ( 0•)	( 0+) +0 +0 ( 1+6) ( +33) ( +0)
3 •560 0 • 0 • 0 • 0 • 0 • 0 • 0 • 0 • 0 • 0	0
9 .560 1 .0000 9.15 .70 21:1	249. 250.0 180.0 10.0 .03 2 30 .0
	(852.) •0 •0 (22.0) ( .92) [ •0]
( .500g)( 55°00) (30.0) (70.0)	
	(*)
APPLIANCE CONCEPT	1 - CABÎN AÎR (CÎRCULATED), LÎTERS/SEC (FT ³ /MÎN) - 2 - CABÎN AÎR (LOST) , KG/HR (LB/HR)
NO. CONCEPT NAHE	3 - OXYGEN (LOST) , KG/HR (LB/HR) 4 - COOLING WATER (CIRCULATED), KG/HR (LB/HR)
1 - INTIMATE PERSONAL ADAPTOR, DISPOSABLE (MATES WITH COMMOD 2 - INTIMATE PERSONAL ADAPTOR, DISPOSABLE (MATES WITH COMMOD	6 - NITROGEN (CIRCULATED), KG/HR (LB/HR)
PORTABLE DISPOSABLE COLLECTOR (TYPE USE COMMERCIALLY)     REUSABLE PORTABLE COLLECTOR	7 - NITROGEN (USED) , KG/HR (LB/HR) 8 - FREON (CIRCULATED), KG/HR (LB/HR)
	9 - WATER (PROCESSED) , KG/HR (LB/HR)
	(***)
· 1 4. 唐· 2. 宋代大概称 (宋代) · 1. [1] · 1. [4] · 1. [4] · 1. [4] · 1. [4] · 1. [4] · 1. [4] · 1. [4] · 1. [4]	(**)AVAILABLE (***)COST INDICATOR
	(1) AVAILABLE 0-25%
98	
ORIGINAL OF POOR	(2) STATE OF THE ART 25-50%  (3) SOME DEVELOPMENT REQUIRED 50-75%



Vomitus Collection/Transfer (Shuttle) Concept Trade

B2-181

NUMBER OF DAYS = 20.5 (.06 YEARS)

USES MOD SUBROUTINE 26

THERMAL PENALTY = DIRECT TO COOLANT (LB/BTUH) .0250

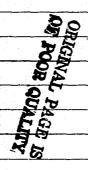
THERMAL PENALTY = CABIN HEAT LEAK (LB/BTUH) .0550

POWER PENALTY (LBS/WAJI) TYPE 1 .5300

SELECTION MATRIX • • • • VOMITUS COLLECTION/TRANSFER (SHUTTLE)
(01/25/75)

·	MIN	MAX				<u> </u>	CONCE	P T
FACTOR				1	2		4	
WEIGHT	1.1500	22.040	15	14-12	13.92	14.22	•.00	<del></del>
POWER	00000	132.50	15_	_15 • CO	15.00_	15.00	00	
	·10000-01						• 6 0	
THERMAL	00000	_46.860	15_	15 • CO.	_15.00_	_15.00	000	
SAFETY DEV COST	•00000 •00000	1.0000 30.000		2 • 5 g	.00 2.50	5.00	5+00 +00	
TOTAL PT	•00000	75.000	75	52.27	52.87	74.11	5.00	
RATING	•00000	100*00	100	69.69	70*49	98•81	6° 67	

02.1181361-2



B2-182

52416

APPLIANCE FUNCTION: 2.1.3-VOMITUS COLLECTION/TRANSFER

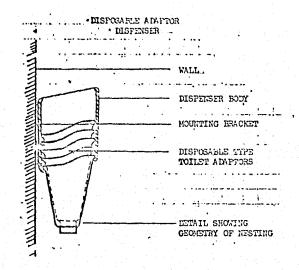
				N U	мв	E R	0	F	C O	M P C	N E	NTS	<del></del>		<del></del>		
COMPONENT TYPE	BLOWER	MANUAL. VALVE										-					NUMBER OF SAFETY CRITICAL ITEMS
APPLIANCE TYPE NO.	18)	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	TIENS
INTIMATE PERSONAL ADAPTER, DISPOSABLE (MATES WITH COMMODE)	-	-							÷			•	-				1
INTIMATE PERSONAL ADAPTER, LINED, REUSABLE (MATES WITH COMMODE)	•	-		•							. 1		•				1
PORTABLE DISPOSABLE COLLECTOR REUSABLE PORTABLE COLLECTOR	- 1	1		•													0
REUSABLE FORTABLE COLLECTOR					• 100	•											
							•							•			•

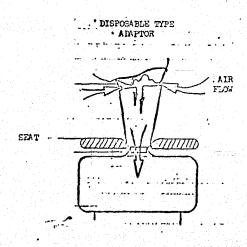
D2-II8561-2

SPACECRAFT	St	uttle	_		• .		
HABITABILITY SU	BSYSTEM Persor	al Hygiene	- _HABITABII	ITY FUNC	Waste TION Trans	Collection fer	1/
APPLIANCE FUNCT	ION Vomitus C	Collection/T	ransfer		and a second		
APPLIANCE CONCE	PT NO./TITLE_	1/Intimate	Personal	Adapter	Disposable		
INDEX NO	2.1.3.1		_REF. NO.	209,186,	187,236, &	commode) 207	
DESCRIPTION The lightweight pla tube of a commo in the top of t	stic or paper de. The adapte	and is shaper blocks the	ed to int e air tra	erface Winsport in	th the fec	es collect Holes	
of the unit is	formed to a cr	ewman's fac	e affecti	ng a seal	over the	nose, arour	nd

the mouth, and under the chin. All vomitus material is expelled directly into the feces collection unit. After use, the adapter is removed and processed in the feces collector. A dispenser for storage of clean vomitus adapters is

located near the feces collector.





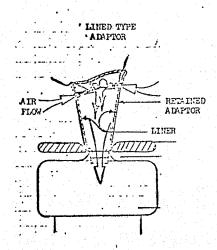
	C . C C T				менте	•	
	EFFF		<u>OWER</u> POWEI	<u> </u>	D C	POWER	
OMPONENT (REF)	USE_TIME CYCLE (HR)	PEAK (WATTS)	③ AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) ① X ③	⑤ PEAK	(A)	DEMAN ATT-H YCLE' DXC
					and the second s		
		***************************************			,		
		MAXIMUM		TOTAL	MAXIMUM		TOT/
		I H E R M A L	REQUIR	<u>EMENTS</u>	•		
SOURCE		LATENT (BTU/HR)	SENS (BTU		HEAT LEAK (BTU/HR)	TO COOL.	
NA							
						*	
				<del>, , , , , , , , , , , , , , , , , , , </del>			
						•	
	TOTAL				· · · · · · · · · · · · · · · · · · ·		
		WATT (BTU/HR)	WATT (	вти/нк)	WATT (BTU/HR)	WATT (BT	U/HI
		•					
		<u> </u>	NAL PE	NALTIES			
	HEA		O COOLANT	ELECTRICAL		VOLUM	
SOURCE	(BTU/HF	t/CYCLE) (BT	U/HR/CYCLE)	(PK WATTS/C	(CLE) (LB/MISSION	Y) (FT³/MIS	2510
	DTAL						
	IIAT (BTU	TS/CYCLE W /HR/CYCLE) (B	ATTS/CYCLE TU/HR/CYCLE)		KG/MISSION (LB/MISSION	N M³/MISS N) (FT³/MIS	3101

## CONCEPT 1/1NTIMATE PERSONAL ADAPTER, DISPOSABLE INDEX NUMBER 2.1.3.1

	FIXED WE	<u>LGHT/VOLUME REQUIR</u>	EMENIS	
COMPONENT DISPENSER	(REF) (186)	WEIGHT (LBS) 279		OLUME (FT ³ ) (23
AUMPTERS	(186)			2 <i>8</i>
			-	
	TOTAL	.60Z (1.329)	. <i>Ö</i> 11	4 (403) (FT3)
	<u>SOLID EXPEN</u>		<u>U I R E M E N T S</u>	
TYPE ADAPT CR.S		(LB)  (100 (100 (100 (100 (100 (100 (100 (10	VOL/UNIT (REF) (PKG. VOL/UNIT)(REF) (FT ³ )	(S) VOL/CYCLE (D) X (A) (FT°)
HUHETERS				• <i>02</i> 47
<u> </u>				
		TOTAL WT/CYCLE (LB)	Σ⑤.	OZAA TOTAL VOL/CYCLE (FT3)
TOTAL WT. = SC	S/DAY X ZO.	SSION X TOT.WT/CYCLE (LB)		(LB) (LB)
TOTAL VOL = 56 MISSION CYCLE	x <u>20.</u> S/DAY A DAYS/MI	SSION xX TOT.VOL/CYCLE (FT3)	007	'9 (28) (FT ³ )
	<u>G A S/L 1 Q U 1 D</u>	EXPENDABLES REQU	<u>IREMENIS</u>	
ТУРЕ	AMT.USED/CYCLE			AMT LOST/CYCLE , ①- ③ , (LB)
N/A				
			•	
	$\Sigma$ $\odot$		Σ@	
TOTAL WT				
CYCLE/D	AY DAYS/MISSION	TOTAL LUST/CYCLE		KG (LB)

SPACECRAF	T	'Sht	uttle '					
HABITABIL	ITY SUBSY	STEM Person	nal Hygiene	_HABITABI	LITY FUNC		aste Coll ransfer	ection/ 
APPLIANCE	FUNCTION	Vomitus	Collection	/Transfer				
APPLIANCE	CONCEPT	NO./TITLE_	2/Intimate	Personal	Adapter,	Lined,	Reusable	(mates
INDEX NO.	2.1.3	.2		REF. NO	. 187,250	0, & 20		ommode)

of metal with provision for attachment of a plastic or paper liner on the inside surface. The adapter is shaped to interface with the feces collector transfer tube. The liner and adapter are provided with holes to allow cabin air into the adapter for vomitus entrainment. The liner is deposited into the feces collector after usage. The adapter is cleaned to maintain hygienic acceptability and stored near the feces collector. One biocide wipe and one dry wipe were assumed to be adequate to clean the reusable liner. Skylab wipe data were used to determine the wipes penalty. The reusable adapter is identical to the Concept 1 configuration.



CONCEPT Z ZINTIMATE	APPLIANC PERSONAL	E CONCEPT REQU AND APPROPRIE	IREMENTS AND	PENALTIES CALC	ULATIONS INDEX N	IUMBER 2.1.3.2
	ELECT	•	<u>POWER</u>	<u>REQUIR</u>		
			C POWI		DC	POWER
COMPONENT (REF)	USE 11ME CYCLE (HR)	PEAK (WATTS)	③ AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) (DX(3)	⑤ PEAK (WATTS)	(A)  O  O  O  O  O  O  O  O  O  O  O  O  O
		MUMIXAM		TOTAL	MUMIXAM	TOTAL
			• • • • • • • • • • • • • • • • • • • •			
	-	HERMAL LATENT	SE	<u>REMENTS</u> ISIBLE	HEAT LEAK	TO COOLANT
SOURCE		(BTU/HR)	(B	TU/HR)	(BTU/HR)	(BTU/HR)
N/a						
	<u> </u>	<del></del>				_
	<del></del> : _					
<del></del>			<del> </del>	<del></del>		<u> </u>
	<del> </del>	<del></del>	-			_
	TOTAL	WATT (BTU/HR)	WATT	(BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)
	<u>0</u>	PERATIO	NAL P	ENALIIE:	<u>.</u>	
SOURCE	HEAT (BTU/HR/0	THERMAL LEAK T CYCLE) (BI	O COOLANT TU/HR/CYCLE)	ELECTRICA (PK WATTS/C		VOLUME ON) (FT³/MISSION)
NA						
	OTAL UATIS (UATIS	/CYCLE / R/CYCLE) (E	IATTS/CYCLE BTU/HR/CYCLE)		, KG/M18810 (LB/M18810	ON M³/MISSION (FT³/MISSION)

B2-188

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

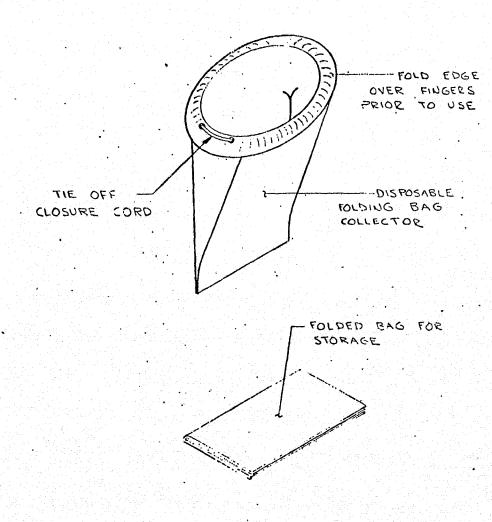
CONCEPT 2/INTIMATE PERSONAL ADAPTER, LINED, RUSABLE INDEX NUMBER 2.1.3.2.

<u>F 1 :</u>	<u>XED WEIGH</u>	IT/YOLUME REQUI	LREMENTS	
COMPONENT DISPENSUR / CINETES* LINUTES	(REF) (187) (187)	WEIGHT (LBS) .312 .352		VOLUME (FT3) • 2253 • 0586
WET/DRY WIPES	(250)	9/8		.04.34
	TOTAL	.718 (1.58)	.0	
<u>s o l l d</u>			QUIREMENIS (4)	M³ (FT³)
TYPE UNITS/CYC	(187)030	② T (REF) WT/CYCLE UNIT)(REF) ① X ② LB) (LB) O.Z (197) .0307	VOL/UNIT (REF) (PKG. VOL/UNIT)(REF (FT ³ )	(FT ³ )
WET WIPES 1		70 (250) .0486 196 (250) .0312	129/70(28 129/196(2	
		∑3 /// 101AL W1/CYCLE	- Σ(§	0089 TOTAL VOL/CYCLE (FT 3)
MISSION = 56 CYCLES/DAY	X ZOS DAYS/MISSIO	•	•	7 <u>8</u> (1.27)
TOTAL VOL = SG CYCLES/DAY	x <u>20.5</u> days/miss10	X .0089 N TOT.VOL/CYCLE (FT3)	.00	29 (.102) M ³ (FT ³ )
<u>G A S/L</u>	Φ Τδ <u>πτ</u>	. 0	UIREMENIS MT.RECOVERED/CYCLE	•  AMT LOST/CYCLE
TYPE - N/A -	AMT.USED/CYCLE(REF) (LB)	RECOVERY FACTOR	OX (LB)	, (LB)
. ΣΦ			Σ@	
TOTAL UT. THIS: ON CYCLE/DAY X	DAYS/MISSION X	TOTAL LOST/CYCLE .		KG (LB)

4			
	有	-1	
1	3	٧.	

SPACECRAF	T <u>S</u>	nuttle			Waste Collection/
HABITABIL	ITY SUBSYSTEM Perso	onal Hygiene	_HABITABIL	ITY FUNCTION_	Transfer Transfer
APPLIANCE	FUNCTION Vomitus	Collection	/Transfer		
<b>APPLIANCE</b>	CONCEPT NO./TITLE	3/Portable	Disposable	Collector (a	irline type)
INDEX NO	2.1.3.3		REE NO	187,207,250,	& 209

drawstring closure device. The bag is used on all airlines and is made of thin gage plastic. The crewman can store the bag in a clothes porket where it will be ready for use at any time. The bag is unfolded and grasped near the opening by both hands and held against the face enclosing the nose and mouth. Proper placement of the bag against the face provides the seal. The bag is sealed after use by tying a knot in the closure cord and discarding the bag and contents into the feces collector.



PORTABLE DISPOSABLE COLLECTOR INDEX NUMBER 2.1.3.3 ELECTRICAL POWER REQUIREMENTS POWER POWER DEMAND (WATT-HR/ CYCLE) (I) X (7) USE TIME DEMAND **(5)** 2 (3) 0 (WATT-HR/ CYCLE PEAK AVERAGE PEAK AVERAGE CYCLE) (HR) (WATTS) COMPONENT (REF) (WATTS) (HATTS) (WATTS) NA MUNIXAM TOTAL MUNIXAM TOTAL REQUIREMENIS THERMAL TO COOLANT HEAT LEAK LATENT SENSIBLE (BTU/HR) SOURCE (BTU/HR) (BTU/HR) (BTU/HR) TOTAL WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) PENALTIES <u>OPERATIONAL</u> VOLUME ELECTRICAL WEIGHT HEAT LEAK TO COOLANT (BTU/HR/CYCLE) (FT3/MISSION) SOURCE (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) NA

B2-191

WATTS/CYCLE (BTU/HR/CYCLE)

TOTAL

WATTS/CYCLE (UTU/HR/CYCLE) (LB/MISSION)

M3/M15510H (FT3/M15510H)

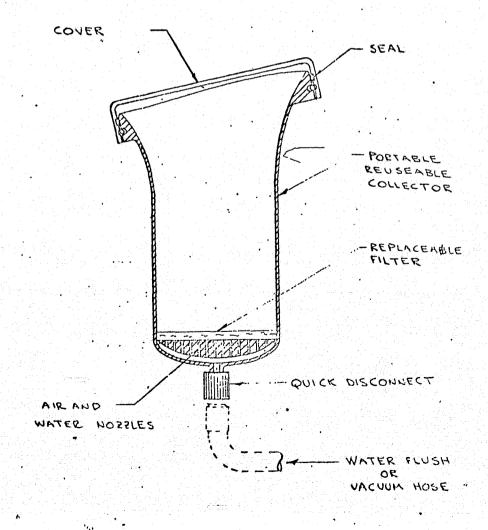
# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED) CONCEPT 3/PORINBLE DISPOSABLE COLLECTOR INDEX NUMBER 2.1.3.3

COMPONENT PONTABLE COLLECTORS	(REF) _(249)	WEIGHT (LBS) /,/5		VOLUME (FT ³ )
	•			
			•	
	TOTAL	.521 (1.15) KG (LBS)	.00	028 (.01) M ³ (FT ³ )
<u>\$0110</u>	<u> </u>	*	<u>JIREMENTS</u>	
TYPE UNITS/CYCLE	WT/UN (PKG.WT	② ③ IT (REF) WT/CYCLE /UNIT)(REF) ① X② (LB) (LB)	VOL/UNIT (REF) (PKG.VOL/UNIT)(REF (FT3)	VOL/CYCLE (1) X (4) (FT ³ )
PORTABLE COLLECTOR		/ (209)	000868@	838000. (10
V.				
		TOTAL WT/CYCLE (LB)	$\Sigma$ (§	TOTAL VOL/CYCLE (FT3)
TOTAL WT. = 56 x	Zo.5  DAYS/MISSI	ON TOT.WT/CYCLE (LB)	• [5	Z/ (1.15) KG (LB)
TOTAL VOL SC CYCLES/DAY	ZO.5 DAYS/MISSI	ON X OOSLS TOT. VOL. /CYCLE (FT3)	.00	028 (01) M ³ (FT ³ )
<u>G A S/L I</u>	ሰ ሀ <b>ነ</b> ባ	PENDABLES REQUI	<u>IREMENTS</u>	
AMT	① .USED/CYCLE(REF, (LB)	② AMT	③ .RECOVERED/CYCLE ① X ② (LB)	MT LOST/CYCLE  . ①-③ . (LB)
TYPE	(LB)	FACTOR	(LB)	'. (LB)
70			<b>S</b> 0	
Σ • _			Σ@	
TOTAL WT. MISSION CYCLE/DAY X	XYS/MISSION X	TOTAL LOST/CYCLE	•	KG (LB)

SPACECRAFT_	Shuttle			Unete Collection
HABITABILIT	Y SUBSYSTEM Personal Hygiene	HABITABILI	TY FUNCTION	Waste Collection/ Transfer
APPLIANCE F	UNCTION Vomitus Collection/T	ransfer		
APPLIANCE C	ONCEPT NO./TITLE 4/Reusable	Portable (	Collector	and the second s
INDEX NO	2.1.3.4	_REF. NO	207	
			•	and a second control of the first

#### DESCRIPTION

The reusable portable collector is constructed of a lightweight metal (aluminum for study) canister type collector with a provision to draw cabin air through it during vomitus expulsion. The resulting entrainment will prevent cabin contamination. The vacuum provision makes sealing at the face less critical than other concepts. A sealing cover prevents spillage. The collector can be used at any vacuum source in the spacecraft. The collector is washed out in a feces collection commode or other suitable debris trap by connecting a flexible flush hose to the collector.



CONCEPT 1/POUSABLE TOOMBLE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

INDEX NUMBER 2.1.3.4

	ELECI	RICAL P		<u>R E Q U I R E</u>	MENIS	POWER
COMPONENT (REF)	USE TIME CYCLE (HR)	② . PEAK (WATTS)	3 AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) ① X ③	(HATTS)	()
FAN ASSY (207)	.017	250	130	3.06	(#M113)	
,				· <del>••••••</del>	•	
				<del></del>		
		250		3.06		
		MAXIMUM .		TOTAL	MAXIMUM	TOTAL
		•			•	
	•					
	. 1	HERMAL	REQUII	REMENIS		
	•	LATENT		SIBLE	HEAT LEAK	TO COOLANT
SOURCE	•	(BTU/HR)		J/HR)	(BTU/HR)	(BTU/HR)
FAN ASSY		N/A	_8	52	852	N/A
		<del></del>				
				·		
	~~··		249.	9(852)	249.9 (852	)
	OTAL _	WATT (BTU/HR)		(BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)
	• • 7					
	. <u>o</u>	PERATION	AL PE	NALTIES		
	HEAT	THERMAL TO	COOLAHT	ELECTRICAL	WEIGHT	YOLUME
\$OURCE *	(BTU/HR/	CYCLE) (BTU	/HR/CYCLE)	(PK WATTS/CY	CLE) (LB/MISSIO	N) (FT ³ /MISSION)
-N/A-						
• 101 • 101	AL					
	WATTS	JCYCLE WATER	TTS/CYCLE J/HR/CYCLE)		KG/MISSIO (LB/MISSIO	M M3/MISSION N) (FT3/MISSION)

B2-194.

### D2-118561:2

# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED) CONCEPT 4/REUSABLE REVINBLE COLLECTOR INDEX NUMBER 2.1.3.4

	FIXED WEI	GHT/VOLUME REQUI	REMENIS	
COLLECTOR	(REF) (207)	WEIGHT (LBS) 2.2		VOLUME (FT ³ )
FILTERS	(207)	.12		.0047
VALVE	(209)	4.00		.03
FAN ASSY.	(209)	10.00		.75
		and the first of the second se	<u> </u>	<del></del>
		***************************************		
		<del> </del>		
	. A			
	<del></del>			
	TOTAL	7.40. (16.32)		26 6921
				M ³ (FT ³ )
		• KG (LBS)		Ma (Fia)
•	COLID EVERNO	ARIE NIMOI BEG	VII TO CHENTO	
	SOLID EXPEND		<u>NUIREMENTS</u>	
	O WT/	OUNIT (REF) WT/CYCLE WT/UNIT)(REF) ①X②	VOL/UNIT (REF)	(S) VOL/CYCLE
TYPE	UNITS/CYCLE(REF) (PKG.	WT/UNIT)(REF) ① X ② (LB)	(PKG. VOL/UNIT)(REF (FT³)	) ① X ④ (FT³)
FILTERS	1 (207)	-01	00908	:00908
				· <del></del>
<u> </u>				
				·
	<del></del>			•
	*	Σ3υ/	Σ.	00008
		TOTAL WI/CYCLE		TUTAL VUL/LYCLL
TOTAL LIT		(LB)		(FT ³ )
MISSION =	6 x Zo. ES/DAY DAYS/MIS	5 x .01	. 52	2.1 (.12)
CYCL	ES/DAY DAYS/MIS	TOT.WT/CYCLE (LB)		KG (LB)
TOTAL VOI				
TOTAL VOL =	6 x 20.5 ES/DAY DAYS/MIS	5 x .00408	-00	133 (.0047)
CYCL	ES/DAY DAYS/MIS	SION TOT. VOL/CYCLE (FT3)		M3 (FT3)
	GAS/LIQUID E	XPENDABLES REQU	IREMENTS	
	0		③ ∏.RECOVEPED/CYCLE	AMT LOST/CYCLE
		ef) RECOVERY AM	T.RECOVEPED/CYCLE	AMT LOST/CYCLE
TYPE	AMT.USED/CYCLE(R (LB)	FACTOR	①x② (LB)	, (LB)
PRETREMMEN	IT		<del></del>	
CHEMICAL	5	·N/A	N/A	5
			<del></del> -	
				<del></del>
	$\Sigma \odot5$		$\Sigma$ (4)	
TOTAL WT.	6 x 20.5	5 5 7	+ N/A .	2.6 (5.74)
CYCLE		TOTAL LOST/CYCLE	'!\ <u>\</u>	KG (LB)

NUMBER OF CONCEPTS CON	SIDERED_	4	
APPLIANCE FUNCTION	2.2.1	Whole Body Shower	
₩ABITABILITY FUNCTION_	2.2_	Cleansing	<del></del>
HABITABILITY SUBSYSTE	2.0	Personal Hygiene	

#### **ASSUMPTIONS**

- (1) Whole body shower concepts enclose the entire body to accomplish whole body cleansing. The showers are similar to terrestrial type; however, water usage is much lower.
- (2) The shower frequency used is one shower per man per day (Ref. 127 and 273). The use time for one shower is 15 minutes (Ref. 127).
- (3) Towels used for drying after showering, if required, are discarded after 60 drying cycles.
- (4) Washer/dryer penalty was based on washer Concept 7, Water Spray Agitation, and dryer Concept 1, Forced Hot Air-Electric Dryer.
- (5) Water used for Space Station body cleansing was assumed to be recycled minus the water loss associated with suspended solids. Shuttle water used is not recycled.

B2-197

APPLIANCE
CONCEPT
NO. CONCEPTNAME

1 - VACUUM PICKUP
2 - AIR DRAG
3 - HECHANICAL
4 - COLLAPSIBLE

156 20 10 24GF 10. CONCEPT NUMBER

. Whole Body Shower (Shuttle) Concept Trade

SELECTION	MATRIX	• •	• •	WHOLE	BODY	SHOWER	(SHUTTLE)
		02/01/	751				

	MIN	MAX	•			C 0 N	C'E_P_T						
FACTOR	VALUE	VALUE	PTS 1	2	3	4							
WEIGHT	792.00	1679.0	15 6.	47 7.92	•00	7.24							 
POWER	52.470		15 14.							-	•		 ····
VOLUME .	61-107	95.083	10 1.	06 1.84	•00	3+57	7						
THERMAL		413.18		0300	7.87_	_12.77							 
RELIAB-Y		•99998	5 5.		5.00								$\sim$
MAINTENC. DEV COST		!•00000 <u></u>		00 <u> </u>			<u> </u>		<del></del>			<u></u>	 
TOTAL PT	i		•	449•77		.= - ,		·.			• • •		 <del></del>
												*	Ğ.
RATING	•00000	100.00	100 61.	80 12.21	51.63	64.29	<del></del>	<del></del>		<del></del>			 <u> —                                   </u>
					•					• .			

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B2-19

- 0

#### APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 2.2.1-WHOLE BODY SHOWER

-			•			Νŧ	JMB	E R	0	F	c 0	M P O	N E	NTS		<del></del>	<del></del>		
	COMPONE  APPLIANCE TYPE	NO.	(I) MOTOR	® BLOWER	(I) HEATER	MDI WD		HEAT EXCHANGER	© WATER SEPARATOR	© FILTER	© CHECK VALVES	CONTROL VALVE	SOL ENOID	(C) MANUAL VALVE	→ ACCUMULATOR	G RELIEF VALVE	E REGULATOR VALVE	0	NUMBER OF SAFETY CRITICAL ITEMS
	VACUUM PICKUP AIR DRAG MECHANICAL COLLAPSIBLE		2 3 - 2	1 1 - 1	1	1 2 - 1	1 1	1 2 -	1 - 1	1 1 1	2 2 -	1 1 -	2 2 -	- 1 2	- - - 1	- - - 1	- - 1		0 0 0
												•				•			-
											,					•			
																			•

<b>SPACECRAFT</b>	Shuttle

HABITABILITY SUBSYSTEM Personal Hygiene HABITABILITY FUNCTION Body Cleansing

APPLIANCE FUNCTION Whole Body Shower

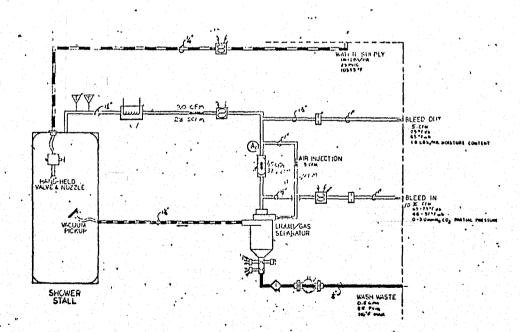
APPLIANCE CONCEPT NO./TITLE 1/Vacuum Pickup

INDEX NO. 2.2.1.1

REF. NO. 127,278,273,236,209, & 129

#### DESCRIPTION

The vacuum pickup concept is a shower stall, which includes a transparent door, and is sufficient in size to allow adequate movement of the crewman during showering and stall cleanup. Water is retrieved by a vacuum pickup system and pumped to the water waste management system. The pickup system allows the crewman to collect water from free air and the stall wall, floor, and door. The shower includes a water distribution system which insures proper cleaning with minimum water usage. A fan is used to circulate air to the shower with a cabin air bleed for carbon dioxide control within the stall. The circulated air is heated to provide a comfortable shower environment. The crewman uses terry towels for drying after showering. The terry towels used for the study are 16 x 24 inches and are assumed to contain one pint of water after drying (278). This concept has been brought to the prototype stage and is scheduled to be tested at NASA JSC.



# CONCEPT 1/VACUUM PICKUP APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS INDEX NUMBER 2.2.1.1

E	L	E	C	T	R	1	C	A	L	P	0	W	Ε	R	F	1	Ε	0	U	Ī	R	E	M	Ε	N	T	S
-	-		-	-	-	-	_	-	_	_	_	_	₩.			•	-	_		ř.	-			-	-	_	-

		A C	PONE	R	D	C POHE	R
COMPONENT (REF)	USE TIME CYCLE (HR)	② PEAK (WATTS)	3 AVERAGE (WATTS)	(4) DEMAND (WATT-HR/ CYCLE) ① X ③	⑤ PEAK (WATTS)	⑥ AVERAGE (WATTS)	(7) DEMAND (WATT-HR/ CYCLE) ① X ⑦
BLOWER (NIC) (127,2 AIR NEGILIE WATUR POMP SOURHOUNDANCES	70) .25 25 25 municipiney		88 104 57.5	22 26 14.4	 		
		249.5 MAXIMUM .		62.4 TOTAL	MAXIMUM		TOTAL

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#### . THERMAL $\underline{\vec{R}} \; \underline{E} \; \underline{Q} \; \underline{U} \; \underline{I} \; \underline{R} \; \underline{E} \; \underline{M} \; \underline{E} \; \underline{N} \; \underline{I} \; \underline{S}$

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
SHOWER BLEED TO CABIN SUDWER DOOR TO CABIN	820	372	372	820
MOISINEEONERIED OUT. BY CROWINN	264	Section 1		264
TOTAL	336.2(1084) NATT (BTU/HR)	109.1°(372) WATT (BTU/HR)	109.1(372) WATT (BTU/HR)	336.2 (1094) WATT (BTU/HR)

#### PENALTIES

SOURCE	HEAT LEAK (BTU/HR/CYCLE)	TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT3/MISSION)
WASHER DRYEK	<u>630</u> <u>45.5</u>	84.7	29.7_ _37.5_	25.1	2.245 2.2
N.					
TOTAL	198.1 (675.5) MATTS/CYCLE (BTU/HR/CYCLE)	24.8 (84.7) WATTS/CYCLE (BTU/HR/CYCLE)	67.2	/5.9 (35.1) KG/MISSION (LB/MISSION)	.126 (4.445) M ³ /MISSION (FT ³ /MISSION)

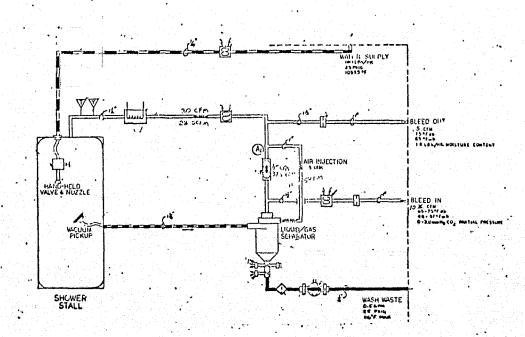
APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

COMPONENT	<u>F 1 X</u>		WEIGHT	QUIREMENTS	VOLUME (FT3)
COMPONENT SHOWER S	mı	(REF) (12.7)	(LBS) 148	<b>7</b>	71.1
COMPONENT:			173		
TOWELS		····	.44	• • • • • • • • • • • • • • • • • • •	.34
			-		
<del></del>					
				,	
MAL PAGE IS POOR QUALITY		1			
PAGETTA		TOTAL	145.8 (32	21.44)	2.02 (7
WAL QUALA			KG (LBS)		M ³ (FT ³ ) ,
POOR .	<u> </u>	EXPENDA	BLE WI/VOL	REQUIREMENT	
	22575			<b>(A)</b>	<b>6</b>
TYPE	UNITS/CYC	(PKG.WT	/UNIT)(REF) (1)X(2)	_E	(REF) VOL/CYC (REF) ① X (4 (FT³)
TOWELS	0166		(LB) 92 <i>(209) .005</i>	and the second s	209) .007
•			22 (236)		(09)
₩.					
• ** <u></u>	· · · · · · · · · · · · · · · · · · ·				· · · · · · · · · · · · · · · · · · ·
			<u> </u>		
			Σ ③ TOTAL WT/0 (LB)	CYCLE	(FT3)
TOTAL WT. =	1		(۱۵)	<i>y</i> =	
	YCLES/DAY	DAYS/MISSIO		[ L	.20 KG (LB)
TOTAL_VOL_			(LB)		
MISSION C	YCLES/DAY	x 20.5 DAYS/MISSI	X X OO 4/ / ON TOT. VOL / CYCI (FT 3)	/ 	M3 (FT.)
			(ri°)		
	GAS/L	TOUTO FX	<u>PENDABLES R</u>	EQUIREMENTS	
	5025		©		<b>(4)</b>
	A)	① 1T.USED/CYCLE(REF	RECOVERY	③ AMT.RECOVERED/CYCLE ① X ② (LB)	(AMT LOST/C (1-3) (LB)
WATER		(LB) 5.0 (27	FACTOR	(LB)	(LB) 5.0
WASHER WI	PTER LOSS	•	O)		
PCHALTY	_	<b>2,</b> 3	KIA	MA	<u> </u>
			•		
	$\Sigma$ ① $_{-}$	7.3		$oldsymbol{\Sigma}$	① <u> </u>

SPACECRAF"	T <u>Shu</u>	ttle	•		
HABITABIL	ITY SUBSYSTEM Person	al Hygiene	HABITABILITY	Y FUNCTION_	Body Cleansing
APPLIANCE	FUNCTION Whole B	ody Shower		······································	
APPLIANCE	CONCEPT NO./TITLE_	2/Air Drag			
INDEX NO.	2.2.1.2		_REF. NO	278, 127	
				•	

#### DESCRIPTION

The air drag concept is the same as Concept 1 with the exception of body drying. Body drying is accomplished by heated air passing over the crewman's body while in the stall. The concept eliminates the requirement for towels and the associated washer/dryer penalties; however, it is a high power consumption unit.



CONCEPT 2/AIR DRAG

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

INDEX NUMBER 2.2.1.2

		•		
, <u>E L E</u> S	CIRICAL PONE	REQUIRE OWER	MENIS DC	POWER
USE TIME CYCLE COMPONENT (REF) (HR)	PEAK AVERA	DEMAND  WATT-HR/ CYCLE)	(5) PEAK	(V) DEMAND AVERAGE (WATT-HR/ CYCLE) (WATTS) ① X ①
BLOWER (AIR) (127) .25 AIR HEATER (127) .25 WATER PUMP (127) .25 CLNOCHSER POP (127) .25	549.9 54 4705.6 470 57.5 5			
CANDENSICENCE (127)				16 =
ORIGINAL PAGE IS	5370.5 MAXIMUM •		16 MAXIMUM	TOTAL
OF POOR QUALITY				
	· IHERMAL RE	QUIREMENIS		
SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
SHOWER BLEED TO CABIN (PE SHOWER DOOR TO CABIN MOISTURE CARRIED OUT BY		27/	<del></del>	702
CLANMAN LOAD	<u>264</u> 14,965			<u>264</u> 14,965
TOTAL	4672 (15,931) MATT (BTU/HR)	79.5(271) WATT (BTU/HR)	79.5 (27/ WATT (BTU/HR)	) <u>4672 (15,93</u> . watt (BTU/HR)
	<u>OPERATIONAL</u>	<u>PENALTIES</u>		
	THERMAL TO COOL/ HEAT LEAK TO COOL/ HR/CYCLE) (BTU/HR/CY	NHT ELECTRICAL (CLE) (PK WATTS/CYC	WEIGHT CLE) (LB/MISSION	VOLUME ) (FT ³ /MISSION)

WATTS/CYCLE (BTU/HR/CYCLE) KG/MISSION)

M³/MISSION (FT³/MISSION)

WATTS/CYCLE (BTU/HR/CYCLE)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 2/AIR DAGG

INDEX NUMBER 2.2.1.2

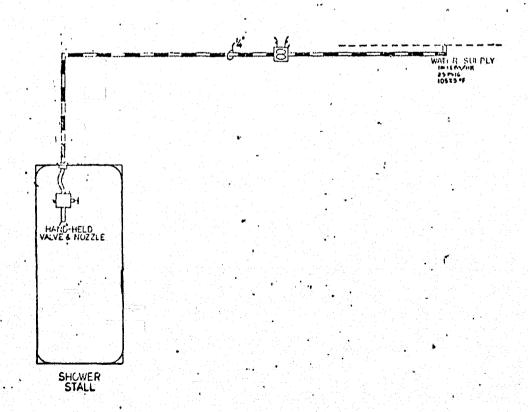
COMPONENT	•(REF)	, • *	WEIGHT (LBS)		VOLUME (FT³)
SHOWER ST.	MLL (127)		148		71.1
ConifONENTS	MODULE 1654 (FET	<i></i>	234-	<u> </u>	
					<del></del>
					*
		*			
AL PAGE TO		٠	1727. 62	527	
PAGE	TOTAL	· L	173.3 (30 KG (LBS)	<u>92)</u>	2.01 (7 M³ (FT³) .
OR QUALA		•	MG (EBS)		No (Fig.)
90M	<u> </u>	PENDABLE	MIVAOF	REQUIREMENT	<u>s</u> ,
	Ф	WT/UNIT (REF (PKG.WT/UNIT)	. ③ F) WT/CYC (REF) ① X ②	REQUIREMENT  (A)  LE VOL/UNIT (RE (PKG. VOL/UNIT) (FT3)	(F) VOL7CYCL
TYPE	UNITS/CYCLE(REF)	(LB).	(LB)	(FT3)	(REF) (1) X (4) (FT ³ )
			<del></del>	چىنىيەت ئىرسىيونلىكىيىد	
				<del></del>	<del></del>
	<del></del>		<del></del>		<del></del>
			Σ3 TOTAL WT/	CYCLE	TOTAL VOL/C
TOTAL UT			(LB)		TOTAL VOL/C
MISSION =	YCLES/DAY X	AYS/MISSION	X	E -	KG (LB)
			(LB)		
TOTAL VOL	CYCLES/DAY X	AYS/MISSION	X TOT. VOL/CYC	· ·	M³ (FT³)
			(FT ³ )		
	<u>G A S/L 1 Q U I</u>			EQUIREMENTS	
		O CYCLE(REF)	@ RECOVERY	AMT.RECOVERED/CYCLE	AMT LOST/CY
TYPE	(	LB)	FACTOR	①x② (LB)	①-③ (LB)
WATER	5.	0 (278)	N/A	· /4//F	<i>5.0</i> ·
		-			
	$\Sigma$ 0 _ 5.	<u> </u>		$\Sigma$	D <u>50</u>
TOTAL WT. MISSION					· 185.97(4

#### D2-1185(1-2

SPACECRAFT Shu	uttle	
HABITABILITY SUBSYSTEM Person	nal Hygiene HABITABILITY FUNCTION Body Cleansing	
APPLIANCE FUNCTION Whole	e Body Shower	
APPLIANCE CONCEPT NO./TITLE_	3/Mechanical	d:in
INDEX NO. 2.2.1.3	REF. NO. 278	- 

#### **DESCRIPTION**

The mechanical shower concept is whole body showering without air recirculation and vacuum water retrieval systems. The water is picked up manually using towels. The towels are washed and dried after use. Five towels per shower (Ref. 278) are required for crewman drying and water pickup. Each towel is assumed to hold 1.0 pints of water. The stall and water distribution system are identical to Concepts 1 and 2. Water recovery from the towels is accomplished by spin drying in the washing machine. The amount of water left in the towel after spin drying is neglected since it is equivalent to towels being washed and then dried. This is a valid assumption because the towels are washed after each shower.



### CONCEPT 3/MECHANICAL

INDEX NUMBER 2.2.13

ELECTRICAL POWER REQUIREMENTS POWER (7)
DEMAND
(WATT-HR/
CYCLE)
① X ⑦ USE TIME (1)
DEMAND
(WATT-HR/
CYCLE)
(1) X (3) 2 (5) 3 6 CYCLE PEAK AVERAGE PEAK AVERAGE COMPONENT (HR) (REF) (WATTS) (WATTS) (WATTS) (WATTS) MAXIMUM TOTAL MAXIMUM TOTAL

#### THERMAL REQUIREMENTS

SOURCE	LATENT (BTU/HR)	SENSIBLE (BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
SHOWING DODR TO CARIN	•	_372_	372.	
MOISTURE CARRIED OUT BY CREWINAN/TOWAS	264			264
				•
TOTAL	77.4 (26.4) WATT (BTU/HR)	(09 (372) WATT (BTU/HR)	109 (372) WATT (BTY/HR)	77. 4 (264) WATT (BTU/HR)

#### OPERATIONAL PENALTIES

SOURCE	HEAT LEAK (BTU/HR/CYCLE)	ERMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT³/MISSION)
WASHER	_3150 ZZ7.5	424	148.6		11.2
DRYEK				50.2	
101/	990.5 AL (3377.5) WATTS/CYCLE (BILL/UB/CYCLE)	/24. (424) WATTS/CYCLE	_336.5_	79.7 (175.6) KG/MISSION	.634 (22.4) M ³ /MISSIGN

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

11DEX NUMBER 2.2.1.3

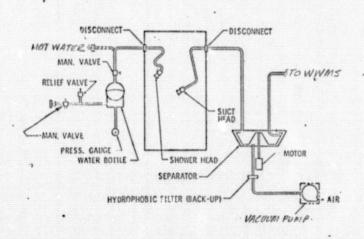
CONCEPT 3/MECHANICAL

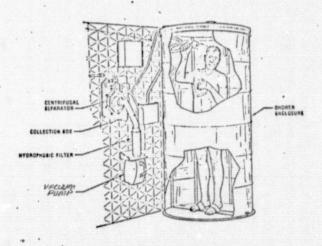
COMPONENT	(REF)	WEIGHT (LBS)	• •	VOLUME (FT ³ )
SHOWER STALL	(127)	193		49
TOWELS (5/SIBWER	2) (279)	. 2.2	· · · · · · · · · · · · · · · · · · ·	1.70
	· · · · · · · · · · · · · · · · · · ·			<del></del>
	<u></u>		<u></u>	
		•		
<u> </u>				
•	•	· · · · · · · · · · · · · · · · · · ·	<del></del>	
	TOTAL	68.1 (150.	2) /.	43 <b>(50.</b> 7)
		KG (LBS)		M3 (FT3)
•				
<u>s o l 1</u>	LD EXPENDA		<u>EQUIREMENTS</u>	
	LIT /III	(I) (REF) WI/CYCLE	VOL/UNIT (REF)	(S) VOL/CYCLE
	(PKG.W)	T/UNIT)(REF) (1)X(2)	(PKG.VOL/UNIT)(REF (FT3)	(FT ³ )
	CYCLE(REF)			·(22.08
Towers .08	3 <u>33 (278)</u> .09 (2 <b>3</b> 6) .3	97 (209) <u>.0268</u>		1 -0208
	(863)			
				<u> </u>
<del></del>				-
				-
		50 07/0	. 50	0208
		$\Sigma$ 3 _ $o$ 268	$\sum$ (	TOTAL VOL/CYCLE (FT3)
		(LB)		(FT ³ )
TOTAL WT. # 4	x 20.5	5 x -0768	- 9	96 (2.2)
CYCLES/DAY	DAYS/MISS	TOT.WT/CYCLE (LB)		KG (LB) (2.2)
TOTAL UNI		(LB)	· · · · · · · · · · · · · · · · · · ·	
TOTAL VOL = 4	x Zo, DAYS/MISS	<u> </u>	<u> </u>	198 (1.70)
CYCLES/DAY	DAYS/MISS	ION TOT. VOL/CYCLE (FT3)		M ³ (FT ³ )
	en de la companya de La companya de la co			
<u>G</u> <u>A</u> !	<u>s/LIQUID</u> E	X P E N D A B L E S R E	QUIREMENIS	
	0	0	AMT.RECOVERED/CYCLE	AMT LOST CYCLE
	AMT.USED/CYCLE(RE	F) RECOVERY	OX (LB)	①-③ (LB)
TYPE		FACTOR	(LB)	(LB)
WATER	5.0			
WASHER WATER	11.5	N/A	1//0	11.5
LOSS PENALTY	_//.3			
~~	16.5		$\Sigma$	16.5
$\Sigma$ (	ر. <u></u> ر		<b>2.</b> •	
TOTAL WT 4				11271
	x 20.5	x 16.5 - 13.4	53 + N/A "	

SPACECRAF	TSh	uttle	
HABITABIL	ITY SUBSYSTEM Person	al Hygiene	HABITABILITY FUNCTION Body Cleansing
APPLIANCE	FUNCTION Whole B	ody Shower	
APPLIANCE	CONCEPT NO./TITLE_	4/Collap	sible (Skylab)
INDEX NO.	2.2.1.4		REF. NO. 279,283,297,282,255,209

#### DESCRIPTION

The collapsible shower concept was used on Skylab. The shower stall is folded down for use to minimize space. The shower enclosure consists of two end ring closures and a translucent Beta cloth skirt with stiffening rings. One end ring attaches to the floor and the other to the ceiling when the shower is in use. Water is delivered through a nozzle with vacuum pickup of water. The waste water is centrifugally separated and routed to the water waste management system. Six pounds of water were used for this concept per shower (Ref. 282). One towel per crewman per shower is used for drying.



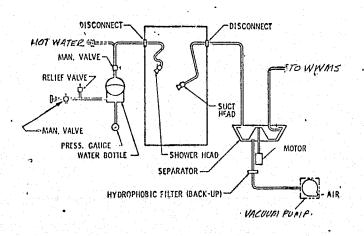


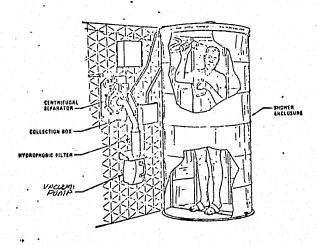
#### D2:118561-2

SPACECRAFT	Sh	nuttle	·		•
HABITABILI	TY SUBSYSTEM Person	nal Hygiene	_HABITABILITY	FUNCTION Body	Cleansing
APPLIANCE	FUNCTION Whole B	Body Shower	•		
APPLIANCE	CONCEPT NO./TITLE_	4/Collaps	sible (Skylab)		·
INDEX NO	2.2.1.4		_REF. NO. 279	,283,297,282,	255,209
				•	

#### DESCRIPTION

The collapsible shower concept was used on Skylab. The shower stall is folded down for use to minimize space. The shower enclosure consists of two end ring closures and a translucent Beta cloth skirt with stiffening rings. One end ring attaches to the floor and the other to the ceiling when the shower is in use. Water is delivered through a nozzle with vacuum pickup of water. The waste water is centrifugally separated and routed to the water waste management system. Six pounds of water were used for this concept per shower (Ref. 282). One towel per crewman per shower is used for drying.





# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT 4/COCLAPSIBLE (SKYCAB)

INDEX NUMBER 2.2.1.4

ELECTRIC	AL PO	WER	REQUIREMENTS

	ELECIR	ICAL P	OWER !	SEQUIRE	MENIS		• , •
,	•	AC	POWER		t	C PO	WER
COMPONENT (REF)	USE TIME  CYCLE  (HR)	PEAK (WATTS)	(WATTS)	(4) DEMAND (WATT-HR/ CYCLE) ① X ③	⑤ PEAK (WATTS)	6 AVERAGI (WATTS	CICLEI
WATER PULL (255)	.25· .25	<u> 28</u> <u> 57.5</u>	_ <u>Z8</u> _57.8	_7.0 _14.4 	Andrew Control of the		
						*	
	,	•		( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( )			
	•	85.5. MAXIHUM,		21.4 TOTAL	MAXIMUM		TOTAL
	•				•		
	I!	HERMAL	REQUIR	EMENIS		•	· · · · · · · · · · · · · · · · · · ·
* SOURCE		LATENT- (BTU/HR)	SENSI (BTU)		HEAT LEAK (BTU/HR)		TO COOLANT (BTU/HR)
SHOWER INCLOSURE		<u> </u>	_80	64	_864		* ************************************
BY CRAUMAN		264					264
		34621	200 1	·	252 860	<u> </u>	77 1611
<b>10</b> 1		7.4 (264) att (btu/hr)	2 <u>53.4(</u>		253.4(8)		77.4 (2G4) WATT (BTU/IIR)

#### OPERATIONAL PENALTIES

SOURCE.	THE HEAT LEAK (BTU/HR/CYCLE)	RMAL TO COOLANT (BTU/HR/CYCLE),	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION)	VOLUME (FT ³ /MISSION)
WASHERE DRYER	630	<u></u> 84.7	<u>29.7</u> 37.5	25.1	2.245
7					
TOTAL	198.1 (675.5) MATTS/CYCLE (BTU/HR/CYCLE)	24.8 (84.7) WATTS/CYCLE (BTU/HR/CYCLE)	67.2	(35.1) KG/MISSION (LB/MISSION)	.126 (4.445) M³/M1SS10N (FT³/M1SS10N)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 4/ COLUMPSIBLE (SKYLAB)

INDEX NUMBER 2.2.1.4

COMPONENT	·(REF)	WEIGHT (LBS)		VOLUME (FT³)
SHOWLYZ SIALL/COMP		157	•	44.34
TOWELS		0.44		0.34
			<del></del>	
		·		<u> </u>
				·
	· · · · · · · · · · · · · · · · · · ·			
	TOTAL	69.15 (152:	14)	1.26 (44.68)
		KG (LBS)		M3 (FT3)
,			F O U I D E W E B T	
<u>s o l 1</u>			EQUIREMENT (4)	
	① WT/UNIT (PKG.WT/UN	(REF) WT/CYCLE	VOL/UNIT (R (PKG.VOL/UNIT	EF) VOL/CYCLE
	/CYCLE(REF) (LB	). (LB)	(FT ³ )	(FT ³ )
Towers .o.	166 (236) 1090	2 (209) <u>.0054</u>		209)00417_
		<del></del>		
				<del></del>
		$\Sigma$ 3 _0054	CIF	$\Sigma$ (5) _004/7 TOTAL VOL/CYCLE
		(LB)		(FI ³ )
MISSION CYCLES/DAY	x 20.5	x _0054	_ =	.20 (.443)
CYCLES/DAY	DAYS/MISSION	TOT.WT/CYCLE (LB)		KG (LB)
TOTAL VOL	x 20.5		_	.0097 (342)
MISSION CYCLES/DAY	DAYS/MISSION	X		M3 (FT3)
		(FT ³ )		
<u>G A S</u>	S/LIQUID EXP	<u>ENDABLES</u> <u>RE</u>	QUIREMENTS	
	•	<b>②</b>	AMT.RECOVERED/CYCL	E AMT LOST/CYCLE
TYPE	AMT. USED/CYCLE (REF)	RECOVERY FACTOR	①x② (LB)	Û-3 (LB)
WATER	6.0 (282)	N/A.	NIA	6.0
WASHERWATER				
LOSS PENALTY	2.3	N/A	K/A	2.3
	**************************************			<del>-i</del>
2-4	02		7	@ <i>8.3</i>
<b>&gt;</b> (1)	1			
$\sum_{k}\mathbb{C}$	8.3			① <u>8.3</u>

HABITABILITY SUBSYSTEM 2.0	Personal Hygiene	 
HABITABILITY FUNCTION 2.2	Body Cleansing	
APPLIANCE FUNCTION 2.2.2	Partial Body Washing	 
NUMBER OF CONCEPTS CONSIDERE	ED 6	•

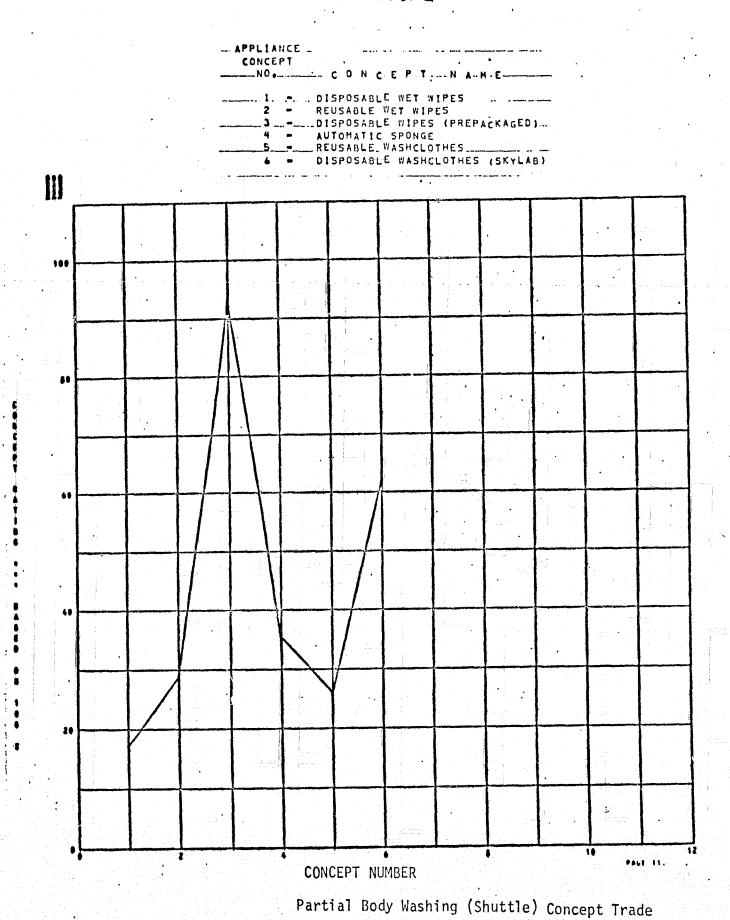
#### **ASSUMPTIONS**

- (1) The partial body washing is the washing of local body areas (i.e., feet, hands, face).
- (2) Washer/dryer penalty was based on washer Concept 7, Water Spray Agitation, and dryer Concept 1, Forced Hot Air-Electric Dryer.
  - (3) Water used for Space Station body cleansing was assumed to be recycled minus the water associated with the suspended solids. Shuttle water used is not recycled.
  - (4) Partial body washing frequency used for the study is 10 times per day per man with a use time of the wetting unit or equivalent of 2.25 minutes per use.
  - (5) Washcloths or reusable paper wipes, if required, are discarded after 60 washing cycles.

	- <del> </del>														83	<b>.</b>	•
			•			AF	PLIANC	E CONCEPT	FUN	CTION MATE	1 X				EB	· · · ·	
	سودية روا سيسود							~						•	176	)	
	INDEX	No. 2.2.	2	. PARTIA	F BODA	WASHING	SHUTT	LE									•
-		,						***		· · · · · · · · · · · · · · · · · · ·			•		and the second s		
_	CONCEPT	USAGE TIME		NSUMABLES	AND FLO	# REGUTE	REMENTS	THE	RHAL	REUNTS	ELEC P	WR REUNTS	MIVAOF	REUNTS	DEVELOPHEN COST	T RES	UPPLY
		USES/DAY				PRESS				HT LEAK	A C	AVG PWR			AVAIL INUE		
-		H82/02E_		(LB/USE)	(*)	PSIG1	DEG	F) (BTU/	15* HR]			-#ATTS-	-KG-	CU_H (CU FT)	(**) (***		LBS)
			*****	• • • • • • • • •	•••••	•••••	•••••	••••••	••••		******	•,		•••••	••••••	•••••	****
	1	40.000 037	2				70•	01 36	0.)_	_( 948+)		240.0	\$33.6 _\$15.01	•60 ( 21•20	2 30		•0
•			9	• 2268 ( • 5000) (	.00	1551 . 4		0		the transfer of	a de la composición dela composición de la composición dela composición de la compos			· 	<u>.</u>		
	2	40.000 .037	<b>5</b>	+0109 +0240)E	.00	1.0		0 10 0) ( 36	5. 0.)	278+	SōI+I .	240.0	208·1 458·8)	.10	230	- (	• 0 • 0 )
7			<del></del> -	• 2268 • 50001 (	.021	-1551+4 (30+0)	( ;	0)	: .				1				
	3	40.000 .037			-			1	D.,	0.	•0	•0	43.5 96.0)	.06	, 1 10		•6
										11+						~	•0
	Y	. 037		( •05001t	.00)	(30+0)		0) [ 144	0.)	1 37+1	• 0	•0	61.71	1 1.51	,		+D).
_	<b>S</b>			•2268 (•5000)(		1551 • 4			5. D.1_	278+ [ 948+]					2 30		• D • D
		.0.000 .037	<u> </u>			1810.0	51.	7 3	2•	30.	57.5	•0	213.9	• 29			•0
• · ·		•03/		• • • • • • • • • • • • • • • • • • • •	•007	135101		0) ( 11	0.7	101.	140.0	. • • • •	N V I • O V	. 10.10	E		•07
		1ANCE					(*)				ria y mana			•	بند و نسود		
		CEPT	CON	CEPT	NAH	Ε	2 -	CABIN AIR CABIN AIR OXYGEN	(	CIRCULATED), LOST)	KG/HR	(LB/HR)	, (*	*)AVAILAB	LE	(	***)COST INDICATOR
				BLE WET WI		·	4 -	COOLING WA	TER (	CIRCULATED),		(LB/HR) (LB/HR)		AILABLE ATE OF TH	F ADT		0-25%
	erre e e dia	3 - (	DISPOSA	ALE WIPES	IPREPAC	KAGEDI		WATER NITROGEN		LOST) CIRCULATED),		(LB/HR) (LB/HR)			E AKI PMENT REOUIREI	·	25-50% 50-75%
		5 - R	EUSABL	E MASHCLOT	HES	<b>c</b> (a.	7 -	NITROGEN FREON	. (	USED)	KG/HR	(LB/HR)	-		EV. REQUIRED	•	50-75% 75-100%
-		<b>♦</b> ₹	ISPOSA	BLE WASHCL	OTHES (	SKYLAB!		WATER	(	CIRCULATED). PROCESSED)	KG/HR	(LB/HR) (LB/HR)					
						e e e e e e e e e e e e e e e e e e e	•						`		<del></del>	<del></del>	**********
					<del></del>	<del></del>		<del></del>	<del></del>								

B2-215

### D2:118561-2



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NUMBER OF DAYS = 20.5 ( .C6 YEARS) USES MOD SUBROUTINE 28 THERMAL PENALTY - DIRECT TO COOLANT (LB/BTUH) +0250 THERMAL PENALTY - CABIN HEAT LEAK (LB/BTUH) +0550 POWER PENALTY (LBS/WATT) TYPE 1 .5300 POWER PENALTY (LBS/WATT) TYPE 2 .4300 ___SELECTION MATRIX . . . . . . PARTIAL BODY WASHING (SHUTTLE) 102/04/751 MIN MAX CONCEST ..... WEIGHT POWER +00 15+00 13+42 +03 9+88 -VOLUME -- 1+5100 -- 21+200 -- 10 -- +00 -- 8+30 -- 8+76 -- 9+29 -- 6+60 -- 5+24 61+140 15 THERMAL .00000 • 0.0 *00 15*00 5*67 *00 12*96 --- RELIAB-Y- 299940 ---- 1.0000 --- 5..... .66 MAINTENC .99999 1.0000 5 1.56 1:56 5:00 :00 1:56 DEV COST 5.0000 50.000 15. 6.00 6.00 12.00 10.00 6.00 13.50. 1185 80.000 80 16.85 25.81 74.77 42.61 14.86 52.27 TOTAL PT .00000 RATING .00000 100.00 100 21.06 32.27 93.46 53.27 18.57 65.33 <u>O</u> . N

ring and a supplication of the second control of the control of th

APPLIANCE FUNCTION: 2.2.2-PARTIAL BODY WASHING

				ΝU	МВ	E R	0	F	C O	M P O	) N E	N T S	<u> </u>			<del></del>	
COMPONENT TYPE  APPLIANCE TYPE  NO	(SEPARATOR	©FILTER	© SOLENOID VALVE	(EXCHANGER	→ ACCUMULATOR	D TEMPERATURE CONTROL VALVE	© CONTROLLER TIMER	CHECK VALVE	dwnd @	(S) MANUAL VALVE	(4) HEATER	RELIEF WALVE	⊕ MOTOR		0	0	NUMBER OF SAFETY CRITICAL ITEMS
DISPOSABLE WET WIPES REUSABLE WET WIPES DISPOSABLE WIPES AUTOMATIC SPONGE (ASTRO-VAC) REUSABLE WASHCLOTHS DISPOSABLE WASHCLOTHS (SKYLAB)	(6) 1 1 1 1	2 2 2 2 2	2 2 2 - 2	1 1 - 1 1	1 1 - 1 1 1	1 1 - 1 - 1 -	1 1 1 1 1 1	1 1 1 1 1 1	- 1 - 1	5		- - - 1	1 1 - 2 1 1	O			0 0 0 0 0
					•												•

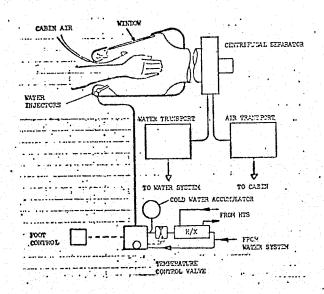
D2:118561-2

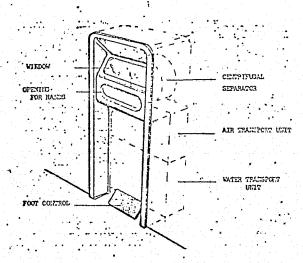
* *

SPACECRAFT	Shi	uttle	•			
HABITABILI	TY SUBSYSTEM Perso	onal Hygiene H <i>F</i>	ABITABILI	TY FUNCTION_	Body	Cleansing
APPLIANCE	FUNCTION Partial	Body Washing				
APPLIANCE	CONCEPT NO./TITLE_	1/Disposab	<u>le Wet Wi</u>	pes		
INDEX NO	2.2.2.1	F	REF. NO	236, 186		

#### DESCRIPTION

The disposable wet wipes concept is a sponge bath technique used to clean local areas of the body. A wetting and soaping unit, with hand holes is supplied for the function. The unit has a water supply outlet, a storage area for soap and a fan for providing water entrainment during use. A centrifugal separator is provided upstream of the blower to collect used water. Water temperature is controlled by mixing hot with cold water in a temperature controlled mixing valve. The crewman first "soaps up" the wipe in the wetting unit, then uses it to clean the required areas of the body. The wipe is wrung out and rinsed inside the wetting unit. The rinsed damp wipe is used to wipe excess soap from the body. A final rinse and wringing out of the wipe is accomplished and the wipe is disposed of by depositing it into a vacuum drier to remove excess water. The dried wipe is then deposited into the refuse system. The disposable wipes are 12 inch squares of 4 ply wet strength paper, 10 of which are supplied per crewman per day.





### APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT // DISPASABLE WET WIPES

INDEX NUMBER 2.2.2.

COMPONENT (REF) (HR) (MATTS) (		ELECI	RICAL PO	WER !	REQUIRE	MENIS		
COMPONENT (REF) (HR) (WATTS) (		•	· A C .	POWER	3	D C	POWE	R
SOC 240 9  SOC 3.0  MAXIMUM TOTAL MAXIMUM TO  I HERMAL REQUIREMENTS  LATENT SENSIBLE HEAT LEAK TO COOLAN  SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR)  WATTER HEAT LOSS 360 378 (948) 278 (948) 1056 3  MATT (STU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  OPERATIONAL PENALTIES  HEAT LEAK TO COOLANT ELECTRICAL MEIGHT VOLUME  SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (FK MATTS/CYCLE) (LD/MISSION) (FT ³ /MISS	6010015117 (DTS)	CYCLE	PEAK , A	WERAGE	DEMAND (WATT-HR/ CYCLE)	PEAK	AVERAGE	(7) DEMAND (WATT-HR/ CYCLE)
SOC 3.0  MAXIMUM TOTAL MAXIMUM TO  I HERMAL REQUIREMENTS  LATENT SENSIBLE HEAT LEAK TO COOLAN SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR)  WATER HEAT LOSS 360 948 998 —  TOTAL 105.6(360) 278 (948) 278 (948) 105.6 (3  MATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  OPERATIONAL PENALTIES  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (LB/MISSION) (FT3/MISS	• •	•				(WATTS)	(WATTS)	①x⑦
SOURCE LATENT SENSIBLE HEAT LEAK TO COOLANT SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR)  TOTAL SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) WATT (BTU/H	WETTIFF ON ( (236)	.03/3	300	240_		***************************************	-	
SOURCE LATENT SENSIBLE HEAT LEAK TO COOLANT SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR)  TOTAL SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) WATT (BTU/H								
SOURCE LATENT SENSIBLE HEAT LEAK TO COOLANT SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR)  TOTAL SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) WATT (BTU/H	Andrean production and the second			······································			<del></del>	•
THERMAL REQUIREMENTS  LATENT SENSIBLE HEAT LEAK TO COOLAN SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR)  WATER HEAT LOSS 360 948 948  TOTAL 105.4(360) 278 (948) 278 (948) 105.6 (3 MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) WATT (BTU/HR)  PPERATIONAL PENALTIES  THERMAL PENALTIES  THERMAL SEQUIREMENTS  WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS				<del></del>				
THERMAL REQUIREMENTS  LATENT SENSIBLE HEAT LEAK TO COOLAN SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR)  WATER HEAT LOSS 360 948 948  TOTAL 105.4(360) 278 (948) 278 (948) 105.6 (3 MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) WATT (BTU/HR)  PPERATIONAL PENALTIES  THERMAL PENALTIES  THERMAL SEQUIREMENTS  WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS								
I HERMAL REQUIREMENTS  LATENT SENSIBLE HEAT LEAK TO COOLAN  SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR)  WATER HEAT LOSS 360 360  MOTORS 948 948 105.6 (3  MATT (BTU/HR) MATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  OPERATIONAL PENALTIES  HEAT LEAK THERMAL' TO COOLANT ELECTRICAL WEIGHT VOLUME SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS			· · · · · · · · · · · · · · · · · · ·	<del></del>	, <del></del>			
IHERMAL REQUIREMENTS  LATENT SENSIBLE HEAT LEAK TO COOLAI  SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR)  WATTER HEAT LOSS 360 — 360  MOTORS 948 998  TOTAL 105.6(360) 278 (948) 278 (948) 105.6(3  WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  PERATIONAL PENALTIES  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME  SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS			500		9.0		•	
LATENT SENSIBLE HEAT LEAK TO COOLAI  SOURCE (BTU/HR) (BTU/HR) (BTU/HR)  WATTER HEAT LOSS 360 — 360  MOTORS — 948 948 — 360  TOTAL 105.6(360) 278 (948) 278 (948) 105.6(3  WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  OPERATIONAL PENALTIES  THERMAL TO COOLANT ELECTRICAL WEIGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS			MAXIMUM .	•	TOTAL	MAXIMUM		TOTAL
LATENT SENSIBLE HEAT LEAK TO COOLAI  SOURCE (BTU/HR) (BTU/HR) (BTU/HR)  WATTER HEAT LOSS 360 — 360  MOTORS — 948 948 — 360  TOTAL 105.6(360) 278 (948) 278 (948) 105.6(3  WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  OPERATIONAL PENALTIES  THERMAL TO COOLANT ELECTRICAL WEIGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS								
SOURCE (BTU/HR) SENSIBLE HEAT LEAK TO COOLAI  (BTU/HR) (BTU/HR) (BTU/HR)  (BTU/HR) (BTU/HR)  (BTU/HR) (BTU/HR)  (BTU/HR) (BTU/HR)  TOTAL 105.6(360) 278 (948) 278 (948)  NATT (BTU/HR) WATT (BTU/HR)  NATT (BTU/HR) WATT (BTU/HR)  NATT (BTU/HR)  OPERATIONAL PENALTIES  THERMAL TO COOLANT ELECTRICAL MEIGHT VOLUME  SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS					•			_
SOURCE (BTU/HR) SENSIBLE HEAT LEAK TO COOLAI  (BTU/HR) (BTU/HR) (BTU/HR)  (BTU/HR) (BTU/HR)  (BTU/HR) (BTU/HR)  (BTU/HR) (BTU/HR)  TOTAL 105.6(360) 278 (948) 278 (948)  NATT (BTU/HR) WATT (BTU/HR)  NATT (BTU/HR) WATT (BTU/HR)  NATT (BTU/HR)  OPERATIONAL PENALTIES  THERMAL TO COOLANT ELECTRICAL MEIGHT VOLUME  SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS								
SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR)  WATER HEAT LOSS 360 — 360  MOTORS 948 948 — 360  TOTAL 105.6(360) 278 (948) 278 (948) 105.6 (3 WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  OPERATIONAL TO COOLANT ELECTRICAL WEIGHT VOLUME SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS		Ī	HERMAL, B	LEQUIR	EMENTS	•		
WATER HEAT LOSS 360 — 360 MOTORS — 948 948 —  TOTAL 105.6(360) 278 (948) 278 (948) 105.6 (3  WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  OPERATIONAL PENALTIES  THERMAL TO COOLANT ELECTRICAL MEIGHT VOLUME SOURCE (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS			LATENT	SENS	IBLE	HEAT LEAK	то	COOLANT
MOTORS — 948 948 —  TOTAL 105.6(360) 278 (948) 278 (948) 105.6 (3  WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  OPERATIONAL PENALTIES  THERMAL' TO COOLANT ELECTRICAL WEIGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS	SOURCE	•	(BTU/HR)	(BTU,	/HR)	(BTU/HR)	(	BTU/HR)
MOTORS — 948 948 —  TOTAL 105.6(360) 278 (948) 278 (948) 105.6 (3  WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR)  OPERATIONAL PENALTIES  THERMAL' TO COOLANT ELECTRICAL WEIGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS	WATER HEAT LOS		360		• · · · · · · · · · · · · · · · · · · ·		-	360
TOTAL 105.6(360) 278 (948) 278 (948) 105.6 (3  WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU,  OPERATIONAL PENALTIES  THERMAL TO COOLANT ELECTRICAL WEIGHT VOLUME SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS		-		99	18	948	-	
WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU,  OPERATIONAL PENALTIES  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (LB/MISSION) (FT³/MISS								
WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU,  OPERATIONAL PENALTIES  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (LB/MISSION) (FT³/MISS		•				, <u> </u>		
WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU,  OPERATIONAL PENALTIES  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (LB/MISSION) (FT³/MISS								
WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU,  OPERATIONAL PENALTIES  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (LB/MISSION) (FT³/MISS			105 ( (210)	270	(010)	270 (44.9)	105	1 (210)
OPERATIONAL PENALTIES  THERMAL TO COOLANT ELECTRICAL WEIGHT VOLUME SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT3/MISS								-
THERMAL'  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME  SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS					,	W. 1. XC. 57 HAY	****	(010/11/7)
THERMAL'  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME  SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS			region (1995). Notae					
THERMAL'  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME  SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS								
THERMAL'  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME  SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISS								
SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT3/MISS		. <u>o</u>	<u>P E R A T 1 O N A</u>	L PEI	<u>NALTIES</u>			
SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT3/MISS			THERMAL		FIFOTOVON	VETCUT		No use
-N/A -	SOURCE		LEAK TO CO	OLANT R/CYCLE)				MISSION)
	- 11/0							
					***************************************			
				<del></del>				
		<del></del>	<del></del>					
<b>数</b> 化三甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基甲基								
								<del></del>

WATTS/CYCLE (BTU/HR/CYCLE)

(LB/HISSION)

M³/MISSION (FT³/MISSION)

WATTS/CYCLE (BTU/HR/CYCLE)

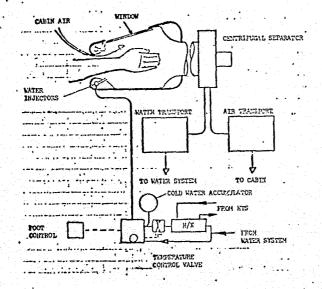
# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED) CONCEPT 1/1X58250BLC WCT WIPCS INDEX NUMBER 2.2.2.1

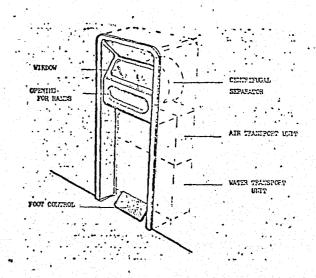
OMPONENT	(REF)	WEIGHT (LBS)	,	VOLUME . (FT ³ )
WETTING UNIT	(236) .	55.69		20.1
DISPOSABLE WIPES	(256)	12.5		1.23
	*			
				•
	-		<u> </u>	
	TOTAL	30.8 (67.99)		604 (21.33)
•	<u> </u>	KG (LBS)	J	M ³ (FT ³ )
				•
<u> </u>	EXPENDAB	<u>LE WI/VOL REC</u> 2) (3)	UIREMENTS (4)	, (5)
	D WT/UNIT (PKG.WT/U	② (REF) WT/CYCLE NIT)(REF) ① X ② B) (LB)	VOL/UNIT (REF) (PKG, VOL/UNIT)(R (FT³)	\$ VOL/CYCLE EF) ① X ④ (FT³)
TYPE UNITS/CY	CLE(REF) (LE	(LB)		
WIPES 1	(236)DI:	5 (234) .015		0015
<del> </del>				<del>-</del>
				<del>-</del>
			***	
		Σ3 O15	$\Sigma$	(5) OOIS
		(LB)		(FT3)
OTAL WT. MISSION = 40 CYCLES/DAY	x 20.5 DAYS/MISSION	XX	* 5	5.58 (12.3) KG (LB)
OTAL VOL = 40	200 0	-		035 (1.23
MISSION = 40 CYCLES/DAY	x 20.5 DAYS/MISSION	XX	<u> </u>	035 (1.23) M ³ (FT ³ )
		(FT ³ )		
N 2 A 3	<u>IQUID EXP</u>	ENDABLES REQU	IREMENTS	
2.192				<b>a</b>
	AMT.USED/CYCLE(REF)	RECOVERY AM	T.RECOVERED/CYCLE	AMT LOST/CYCLE  ①-③
TYPE	(LB)	FACTOR	(LB)	(LB)
OXYGEN(WIPEDISLUSIL) . WATER	.000719	N/A	N/A	-000719
WATER LOSS (LOSS	.0144	NA	N/A·	.0444
IN DISPOSED WIFE)				
	in the factor of the second			
ΣΦ	.545	•	Σ (1)	.545
otal wt. 40 x	tij jako kantoritiko	المنافي والمستند ووارات		

SPACECRAFT_	Shu	ttle	· · · · · · · · · · · · · · · · · · ·		•
HABITABILIT	Y SUBSYSTEM Person	al Hygiene	HABITABILIT	Y FUNCTION Body Clean	sing
APPLIANCE FU	JNCTIONPartia	al Body Wa	shing		
APPLIANCE CO	ONCEPT NO./TITLE_	2/Reusal	ble Wet Wipes		<del>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</del>
INDEX NO.	2.2.2.2	<del> </del>	REF. NO	236, 186	<del></del>

#### **DESCRIPTION**

The reusable wet wipe concept is a sponge bath technique used to clean local areas of the body. The wetting unit described in Concept 1 is also required for this concept. The reusable wipes, however, are wrung out in the wetting unit and reused. Reusable wipes are provided on a per man basis. The wipe is washed and dried using a washing machine and dryer. After 60 washings, the wipe is discarded and replaced. The reusable wipes are 10 inches square of 4 ply "wet strength" paper.





## APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT 2/REUS PBUE WET WIFES

INDEX NUMBER 2.2.2.2

	ELECIRICAL		<u>REQUIRE</u> !		POWER
COMPONENT (REF)	SE TIME (2) CYCLE PEAK (HR) (WATTS) 0375 500	(WATTS)	DEMÂND (WATT-HR/ CYCLE) ①X③		(F) (B) (DEMAND ERAGE (WATT-HR CYCLE) ATTS) (D X (7)
			9.02		
	SOC MAXIMU		TOTAL	MAXIMUM	TOTAL
					•
	<u> </u>	L. REQUI	REMENIS		
SOURCE	LATENT (BTU/HR)		ISIBLE U/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT LOSS	_360	· · · · · · · · · · · · · · · · · · ·			360
MOTORS			948	948	
	•			•	
TOTAL	105.6 (3 WATT (BTU/		3 (949) (BTU/HR)	278 (948) WATT (BTU/HR)	105.6 (36) WATT (BTU/HR)
	<u> </u>	IONAL P	<u>E N A L T I E S</u>		
SOURCE	THE HEAT LEAK (BTU/HR/CYCLE)	RMAL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYC	WEIGHT LE) (LB/MISSION)	VOLUME (FT ³ /MISSION)
WASHUR	10.95		.516	.436	.0,39
DRYER			.653	.174	.038
	3.44	.43		377	.002
TOTAL	MATTS/CYCLE (BTU/HR/CYCLE)	(1.47) WATTS/CYCLE (BTU/HR/CYCLE)	1.169	.277 (.610) KG/MISSION (LB/MISSION)	(077) M ³ /MISSION (FT ³ /MISSION)

# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED) CONCEPT 2/BLUSHBLC WET WIPES INDEX NUMBER 2.2.2.2

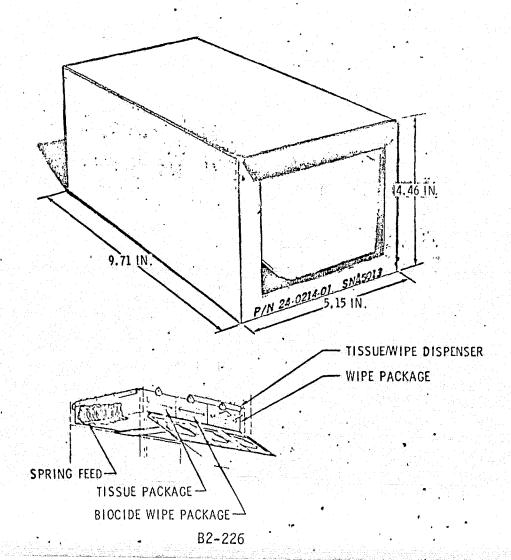
	<u>FIXED</u> WE	IGHI/VOLUME RE	QU.IREMENIS	
COMPONENT	· /prr\	WEIGHT		VOLUME
_	(REF)	(LBS) 28.49		(FT ³ )
WETTING UNIT REUSABLE WIPES	(236) (236	.059		.034
CLUSHOLL WIFE.	عادت)		<u> </u>	• • • • • • • • • • • • • • • • • • • •
	•		<del></del>	
	<del></del>			
<del></del>			-	
		•		
	•			· · · · · · · · · · · · · · · · · · ·
	TOTAL	12.9 (28.	545)	.10 (3.534)
		KG (LBS)		M ³ (FT ³ )
			6.5	
<u>s o l</u>	<u>ID EXPE</u>	DABLE WT/VOL	REQUIREMEN	<u>I S</u> ,
		л/UNIT (REF) WI/CY	CLE VOL/UNIT	(REF) VOL/CYCLE
	(P)	(G.WT/UNIT)(REF) (1)X(	2) (PKG.VOL/UNI) (FT3)	IT)(REF) VUL/CYCLE
	S/CYCLE(REF)	(LB) (LB		
WIPES	1 (236)	2000667(24) .0000	0667 .00000	72(23).000042
<b>V</b>				
	<del>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</del>	<u> </u>		
		$\Sigma$ $3$ $_{ ilde{ idde{ idde{ ilde{ ii}}}}}}}}}}}}}}}}}}}}}}}}}}}}}}}}}}}$	0667 -	∑ ⑤ .00004Z TOTAL VOL/CYCLE
		LB	)	(FT ³ )
TOTAL WT. = 40	, g	2 5 0000	/ 7 .	025 (055)
MISSION = 40 CYCLES/DAY	DAYS/I	2.5 x <u>.0006</u>	<u>2/                                  </u>	.025 (.055)
		(LB)		
TOTAL VOL = 40	v 20	.5 x .0000A	7 -	.00097 (.034)
MISSION CYCLES/DAY	DAYS/I	ISSION TOT. VOL/CY		M ³ (FT ³ )
		(FT ³ )		
<u>G /</u>	S/LIQUID	EXPENDABLES	<u>REQUIREMENT</u>	<u>\$</u>
		0		
	<b>①</b>	PECONEDA	AMT. RECOVERED/CY	CLE AMT LOST/CYCLE
TYPE	AMT.USED/CYCL	FACTOR	① X ② (LB)	①-③ (LB)
WATER		(236) N/A	N/A	5
WASHER WATER				
LOSS PENALTY	.024	N/A	N/1	.024
	••			
<del>مين دريو دريو دريو مين دريو دريو دريو دريو دريو</del>	<u> </u>		<u> </u>	
$\sum_{i} c_i$	① <u>.524</u>			CO
TOTAL WT. 40	, 705	v 674	729.7 · N/A	- 194.9 (429.7)
CYCLE/DAY	$-x = \frac{20.5}{DAYS/MISSIO}$	TOTÁL TOST/CYCLE	Landel " 14/7	KG (LB)

SPACECRAF"	T	Shuttle	·		
HABITABIL	ITY SUBSYSTEM Person	al Hygiene	HABITABILIT	Y FUNCTION_	Body Cleansing
APPLIANCE	FUNCTION Partial	Body Wash	ing		
APPLIANCE	CONCEPT NO./TITLE_	3/Dispos	able Wipes (SI	kylab)	
INDEX NO.	2.2.2.3		REF. NO	250, 283	

#### DESCRIPTION

The disposable wipes concept is made up of prepackaged wipes which were used on Skylab. The wipes are contained within a package to eliminate water evaporation during storage. The units are used and discarded. The Skylab size wipe weight and volume were ratioed (6.3) to the 10 inch square wipes used in Concepts 1 and 2 in order to provide an equivalent trade.

Wipe Dispenser



CONCEPT 3/1575556 WIPES (SKYLAR)

INDEX NUMBER 2.2.3.3

	ELECIE	TCVT	·	<u>R E Q U 1 R E M</u> R	ENIS DC	POWER
COMPONENT (REF)	USE TIME CYCLE (HR)	PEAK (WATTS)	③ AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) ① X ③		(f) (g) DEMAND VERAGE VERAGE VERAGE VERAGE (WATT-HR CYCLE) WATTS) (1) X(2)
		•				
		MUMIXAM		TOTAL	MAXIMUM	TOTAL
		•				
SOURCE	<u>I</u>	LATENT (BTU/HR)	SENS	REMENIS. SIBLE J/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
NA						
	<del></del>					
	TOTAL _					
		WATT (BTU/HR)	WATT (	(BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)
	<u>0</u>	PERATIO	<u>NAL PE</u>	NALTIES		
SOURCE	HEAT (BTU/HR/C	LEAK	TO COOLANT TU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYC	MEIGHT (LB/MISSION	VOLUME ) (FT³/MISSION)
N/A						
	OTAL NATTS	/CYCLE R/CYCLE) (	WATTS/CYCLE BTU/HR/CYCLE)		KG/MISSION (LB/MISSION	M³/MISSION ) (FT³/MISSION)

B2-227

### D2-118561;2

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 3/DISPOSABLE WIFE'S (SICYLAR)

INDEX

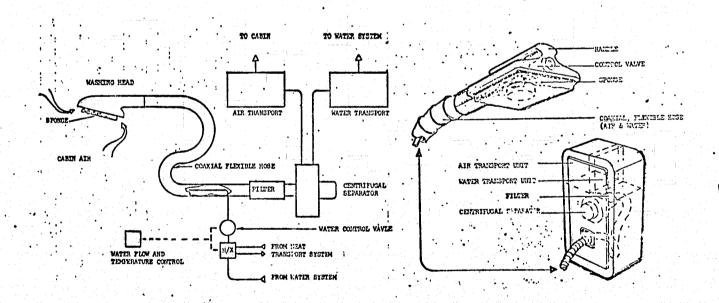
INDEX NUMBER 2.2.2.3

	WEIGHT		VOLUME (FT ³ )
OMPONENT (REF)  WIP (S/PNCKACING (250)	(LBS) 96.1		(FI)
			······································
		ı	
	See about 11 to the second sec	<del></del>	·
7074	13 ( (0(1)		ים ים יסי
TOTAL	43.6 (96.1) KG (LBS)		(3 (Z.ZÓ) 13 (FŢ3)
<u>SOLID</u> <u>EXPENDA</u>		QUIREMENTS	
TYPE UNITS/CYCLE(REF)	② IT (REF) WT/CYCLE /UNIT)(REF) ① X ② (LB) (LB)	VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT3)	(5) VOL/CYCLE (1) X (4) (FT ³ )
WIPES 1 (236) 5.6/	301(13/m:line) .1172	129/301(63)(#	DN :0027
	· · · · · · · · · · · · · · · · · · ·		
	Σ3 1/72. TÖTAL WT/CYCLI	Σ⑤	TOTAL VOL/CYCLE
OTAL WT. = 40 x 20.5 CYCLES/DAY DAYS/MISŞIR	X 1/72 ON TOT.WT/CYCLE (LB)	• 43	3.6 (96.1 kg (LB)
OTAL VOL # 40 x 20.5  WISSION = 40 x DAYS/MISSION DAYS/MI		•	3 M ³ (FT ³ )
<u>6                                    </u>		UIREMENTS	
AMT.USED/CYCLE(REF.	RECOVERY FACTOR	③ AMT.RECOVERED/CYCLE ① X ② (LB)	AMT LOST/CYCLE  () - (3) (LB)
		-	
Σ ①		ΣΦ	
OTAL WT. MISSION X CYCLE/DAY X DAYS/MISSION X	TOTAL LOST/CYCLE (LB)		KG (LB)

SPACECRAF	TShu	ıttle	•		
<b>HABIT</b> ABIL	ITY SUBSYSTEM Person	nal Hygiene I	HABITABILITY	FUNCTION Bod	y Cleansing
APPLIANCE	FUNCTION Partial	Body Washing			· · · · · · · · · · · · · · · · · · ·
APPLIANCE	CONCEPT NO./TITLE_	4/Automati	c Sponge		
INDEX NO.	2.2.2.4		REF. NO.	236, 100	

#### **DESCRIPTION**

The automatic sponge concept is a hand-held scrubber head connected by coaxial flex tubing to a water supply valve and an air transport system. Water is fed into a sponge in the scrubber head for use in cleaning the body. A water pickup housing connected to the vacuum line surrounds the sponge. A water separator is used to collect water from the cabin air. A pump unit injects the water into the water waste management system. Each crewman has a sponge and is provided with one sponge per month to fit the scrubber head.



APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT 4/AUTOMOTIC SPONGE

INDEX NUMBER 2.2.2.4

M3/MISSION)

KG/MISSION (LB/MISSION)

•	ELECI	RICAL !	POWER	REQUIRE	MENIS	en e
COMPONENT (REF)  AUTOMATIC SPONGE  UNIT (236)	USE TIME CYCL'E (HR) -0375	PEAK (WATTS) _52.8	3 AVERAGE (WATTS) 31.7	DEMAND (WATI-HR/ CYCLE) ①X③		POWER  (DEMAND VERAGE (WATT-HR/ CYCLE) WATTS)  (WATT-HR/ CYCLE)
		52.8				
		MAXIMUM .		TOTAL	MAXIMUM	TOTAL
		I H E R M A L	REQU	<u> </u>		
SOURCE		LATENT (BTU/HR)		ENSIBLE BTU/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HEAT MOTORS	<u>LOS</u> S	1440		36.7	36,7	1440
	TOTAL	422.3(14 WATT (BTU/HR)		. <i>8 (36.</i> 7) T (BTU/HR)	10.8 (36.7) WATT (BTU/HR)	422.3(14-40 WATT (BTU/HR)
		<u> </u>	DNAL E	<u>PENALTIE</u>	<u> </u>	
SOURCE	HEA (BTU/HI	THERMAL AT LEAK R/CYCLE) (E	TO COOLANT STU/HR/CYCLE	ELECTRICAL (PK WATTS/C		VOLUME (FT ³ /MISSION)
			•			

WATTS/CYCLE (BTU/HR/CYCLE)

WATTS/CYCLE (BTU/HR/CYCLE)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

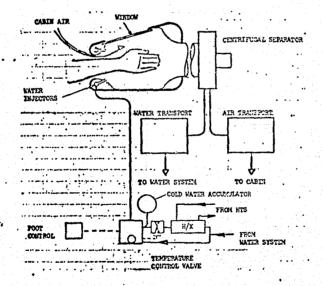
SPONGE
INDEX NUMBER 2.2.2.4

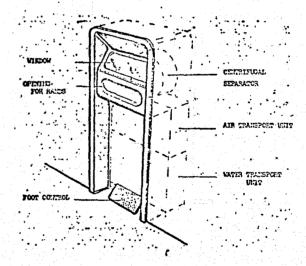
INCOMENT INCOME	•	WEIGHT (LBS)		VOLUME (FT³)
ONENT (REF) TOMATIC SPONGE UNIT (23	۵)	20.6		1.5
ONGUS	9	0.081		0.013
			· · · · · · · · · · · · · · · · · · ·	
	<u></u>	· · · · · · · · · · · · · · · · · · ·		<u> </u>
			-	
		<u> </u>		
<u> </u>			- ' , <del></del>	
<u> </u>	<del>(************************************</del>		-	
TOTAL	9.3	38 (20.681)	1	.043 (1.513 ₎
		KG (LBS)	المرسيسا	M ³ (FT ³ )
		internation of the state of th		
<u>SOLID EX</u>	PENDABLE		UIREMENI	
0	WT/UNIT (REF)	WI/CYCLE	VOL/UNIT (R	EF) VOL/CYCLE
TYPE UNITS/CYCLE(REF)	(PKG.WT/UNIT)(REF	) ①x② (LB)	(PKG.VOL/UNIT (FT ³ )	)(REF) . ①X ④ (FT³)
PONGES .033 (234)	.002989	.0000986	.000491	000015
		- ·		
		<u>-</u>		
		7		•
	$\sum$ (	3 .000986 TOTAL WT/CYCLE		Σ (§ .0000159
		(LB)		TOTAL VOL/CYCLE (FT3)
IL WT. = 40 x	20.5 x	0000986	•	.037 (.081
$\frac{\text{AL W1.}}{\text{SION}} = \frac{40}{\text{CYCLES/DAY}} \times \frac{1}{\text{CYCLES/DAY}} \times \frac{1}{CYCLES/DAY$	AYS/MISSION X	.0000986 TOT.WT/CYCLE .(LB)	<del></del>	KG (LB)
NL VOL = 40 x			_	
SSION = 40 x D	ZO.5 x _	.0000/59	•	.000369 (.013)
		(FT ³ )		
	•		;-	
GAS/LIQUI	<u>D EXPENDA</u>	BLES REQU	IREMENIS	
	<b>o</b>	0	O T.RECOVERED/CYCL	E AMT LOST/CYCLE
AMT.USED/	CYCLE(REF)		: (1) X (2)	. (LB)
	LB) (236)	FACTOR N/A	(LB)	(LB)
THI ER	2 (556)	<i>M///</i>	_1×//-	
			•	
			*	
70	<u> </u>	<del></del>		O 05
$\Sigma \odot$ $o$	<del></del>	an Asia Septimber	Σ	(a) <i>.o</i> .s
AL WT 40 x 20				. 18.6 (41.0)
an - an - n		_ ///	1	-1 1/5 W 1410

SPACECRAFT	Shu	ttle	1 * 1 1		
HABITABILITY	SUBSYSTEM Perso	nal Hygiene	HABITABILI	TY FUNCTION BODY C	leansing
APPLIANCE FUI	NCTION Partial	Body Washing			ومعربي والمتاريخ والمتارغ والمتاريخ والمتاريخ والمتاريخ والمتاريخ والمتاريخ والمتاريخ
APPLIANCE CO	NCEPT NO./TITLE_	5/Reusable	Washcloth	<b>S</b>	· · · · · · · · · · · · · · · · · · ·
INDEX NO. 2	2.2.2.5		_REF. NO	236,237,245,209	

#### DESCRIPTION

The reusable washcloths concept is the same as Concept 2; however, terry washcloths are used for cleansing cloths. The terry washcloths are 6 inches square. The washcloth is used for 60 washings then is discarded and replaced. The washcloth is washed and dried daily using a washing machine and dryer.





#### APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

CONCEPT SIREUSABLE WASTICLOTHES

. .

INDEX NUMBER 2.2.2.5

•	•	A C	POWER	1000	D	C PO	WER
OMPONENT (REF)	(HR) (W	ATTS) (F	③ VERAGE NATTS) 240.5	DEMÂND (WATT-HR/ CYCLE) ① X ③	E PEAK (WATTS)	6 AVERAGE (WATTS)	CICLE
						,	
				9.02			
		(IMUM •			MAXIMUM		TOTAL
	•						
	· IHE	RMAL B	<u>EQUIR</u>	EMENIS		<b>:</b>	
SOURCE		TENT U/HR)	SENS (BTU		HEAT LEAR (BTU/HR)		TO COOLANT (BTU/HR)
WATER HEAT LOS	ss <u>3</u>	60		<u>.</u> 48	948	<u></u> -	_360
MOTOPLS					770	•	
			*		<u> </u>		•
		(360) (BTU/HR)	278 WATT (1	(948) STU/HR)	278 (99 HATT (BTU/H	1 <i>9)</i> IR)	105.6(36 WATT (BTU/HR)
	<u>OPER</u>	AIIONA	L PEN	ALTIES			
SOURCE	HEAT LEAK (BTU/HR/CYCLE)	THERMAL' TO COC (BTU/HR	OLANT /CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGH (LB/MISS		VOLUME (FT3/MISSION)
WASHER	414	. • 		19.5	16:		1.474
DRYER			5.5	24.6	6.8	59 <u> </u>	1.45
						<del></del>	
	130.2		.6		10.9	17	.083

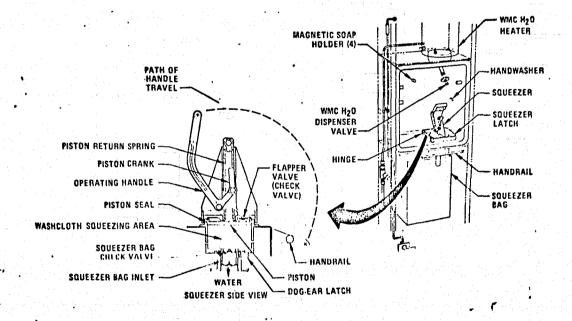
# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS. (CONCLUDED) CONCEPT. SIRUSABLE WISHCLOTHES INDEX NUMBER 2.2.2.5

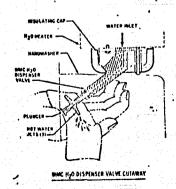
<u>F 1</u> .	XED WEI	CO H T/V O L	UME RE	QUIREMEN:	<u>T S</u>	
COMPONENT WETTING UNIT	(REF) (236)		WEIGHT (LBS)		<u>.</u>	VOLUME (FT ³ ) 3. 5
WASH CLOTHES			1.07 -			.746
		<del></del>	<del></del>	•		
			•			•
			``			
			·	<del></del>		
	TOTAL	/3	3.41 (29.	56)	./2	(4.246)
	•		KG (LBS)		<u> </u>	³ (FT ³ ) ·
			11 <b>7</b> 11 A 1		-га те	
<u> </u>	EXPEN	DABLE  (2) (JUNIT (REF) (S. WT/UNIT)(REF (LB) (LB)	MI/CAČI MI/CAČI	REQUIREM	<u>E M I ≥</u>	<b>6</b>
	D (PK)	「/UNIT (REF) S.WT/UNIT)(REF	WT/CYCI	LE VOL/U ) (PKG.VO	NIT (REF) L/UNIT)(REF) FT³)	(5) VOL/CYCLE ① X ④ (FT³)
TYPE UNITS/CY WASH CLOTHES Ollow	CLE(REF)	.077	(LB)	? <i>0</i> 4	ft³) <b>146 (209)</b>	.00091
WASH COURTS OUT					10 (01)	
<b>X</b>	<del></del>					*
						•
			= ,			
		$\sum ($	3 <u>,00/3</u>	CVC) E	$\Sigma$ (§	10TAL VOL/CYCLE
			(LB)	01000		(FT ³ )
TOTAL WT. = 40 CYCLES/DAY	x ZO	S x	00/3	<b>.</b>	.48	3 (1.07) G (LB)
TOTAL VOL = CYCLES/DAY	x ZO.	.5 x	.0009/	LE	.02	(.746)
	• 50 00 000		(FT ³ )			
		E V 0 E N 0 7		F D 11 T D E 4 F	NTC	
<u>6 ₩ 3/F</u>		EXPENDE		EQUIREME. O		<b>.</b>
	AMT.USED/CYCLE	/DEEN	RECOVERY	AMT. RECOVERE	D/CYCLE	AMT LOST/CYCLE
TYPE	(LB)		FACTOR	① X (2 (LB)		①-③
WATER		(236)	N/A	<u>N/A</u> _		5
WASHER WATER	.960		NA	N/A		.906
					_	
				<del></del>		
Σ①	1406			<del></del>	ΣΦ.	1.406.
20	ITUO		ing a			
TOTAL WT. 40 x	20.5	x 1.4	0- 11	53 + A	1/4 - [.	523 (1153)
CYCLE/DAY	DAYS/MISSION	TOTAL LO	ST/CYCLE		<i>γε</i> ι	KG (LB)

SPACECRAFT Sh	uttle	
HABITABILITY SUBSYSTEM Perso	nal Hygiene HABITABILITY FUNCTION	Body Cleansing
APPLIANCE FUNCTION Partia	1 Body Washing	
APPLIANCE CONCEPT NO./TITLE_	6/Disposable Washcloths (Skylab)	
INDEX NO. 2.2.2.6	REF. NO. 236,283	

#### **DESCRIPTION**

The disposable washcloths concept is the system used on the Skylab vehicle. The terrycloth washcloths are wetted by depressing a water supply valve. The unit will provide warm water from a heated storage tank. After the cloth is used, it is squeezed using a manual squeezer unit. The water squeezed from the washcloth is recovered and routed to the water waste management system. One washcloth is provided per man per day. The washcloths are disposed of by deposit into a vacuum drier to remove excess water. The dried cloth is then deposited into the refuse system.





# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT 6/DISPOSABLE WASHCLOTHES

INDEX NUMBER 2,2.2.6

•	ELECIE	I CAL P	OWER	REQUIRE	M E N T S	in the second se
			POWE	R	D C_	POWER
COMPONENT (REF) HENTER (25)	USE TIME CYCLE (HR)	PEAK (WATTS)	③ AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) (D X (3)	© PEAK (WATTS)	() Demand () WATT-HR/ CYCLE) (WATTS) D X () (WATTS) D X ()
WATET PUMP	.0375	57.5	<i>\$7.5</i>	2.15		
		57.5 MAXIMUM		_2.15 TOTAL	140 MAXIMUM	5.2 <u>4</u>
		HERMAL	REQUI	<u>REMENIS</u>		
SOURCE		LATENT (BTU/HR)		SIBLE U/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
WATER HOAT LOSS	<del></del> +-	110				
HEATER				71.6	71.6	
WATER PUMP		52.3 <i>(110)</i> NATT (BTU/HR)	<u></u>	(S(101.0) (BTU/HR)	29.4 · · · · · · · · · · · · · · · · · · ·	32.3 (110) WATT (BTU/HR)
		•				,
	· <u>0</u>	PERATIO	NAL PE	NALTIES		
SOURCE	HEAT (BTU/HR/0	THERMAL' LEAK T CYCLE) (BT	O COOLANT U/HR/CYCLE)	ELECTRICAL (PK WATTS/CY	WEIGHT	VOLUME (FT3/MISSION)
- N/A -						
10	MATTS (BTU/H	/CYCLE WIR/CYCLE) (B	ATTS/CYCLE TU/HR/CYCLE)		KG/MISSI (LB/MISSI	ON M3/M15510H ON) (FT3/M15510H)

WATTS/CYCLE (BTU/HR/CYCLE)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 6/DISPOSABLE WASHCLOTHES

INDEX NUMBER 2.2.2.6

COMPONENT (REF)	WEIGHT (LBS)	•	VOLUME (FT ³ )
5 JUE 6-71-18/WHIER DISPENSION (MSAN)	32.4	•	115
L'ASH CLOTHES	8.84		8.95
		-	
· ·	•		
		<del></del>	<del>.,,,</del>
teritoria antigrati de transcriutoria de la compositiona della composi		-	<u> </u>
TOTAL	18.7 (41.24)	.2	86 (10.10)
	KG (LBS)		M ³ (FT ³ )
<u>SOLID EXPENDAB</u>	LE WI/VOL REG	<u>UIREMENTS</u>	•
LT (INI)	(055)	401 (1017)	<b>©</b> VOL/CYCLE
(PKG.WT/UNIT)	(REF) ₩T/CYCLE IT)(REF) ① X ② ). (LB)	VOL/UNIT (REF) (PKG.VOL/UNIT)(RE	F) ①X④ (FT³)
TYPE UNITS/CYCLE(REF) (LB	). (LB)	(FT ³ )	(FT3)
WASH CLOTHES 1 (283) .107	18 (237) .01078	0546 100	201092
,			<b>-</b>
			<del>-</del>
·			-
			_
			<u> </u>
	Σ3 .01078	$ \Sigma$	0/097
	TOTAL WI/CYCLE		TOTAL VOLZCYCLE
TOTAL SUTTER STATE OF THE STATE	· (LB)		(FT ³ )
TOTAL WT. 40 x 20.5  CYCLES/DAY DAYS/MISSION	_x01078	4.	0 (8.84)
CYCLES/DAY DAYS/MISSION	TOT.WT/CYCLE (LB)		KG (LB)
MISSION 40 x 20.5		<u> </u>	1000
MISSION 4 20.5  CYCLES/DAY DAYS/MISSION	x	<u> </u>	253 (8.95) N ³ (FT ³ )
	(FT ³ )		
	- 1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1	***************************************	
GAS/LIQUID EXP	<u>ENDABLES REQU</u>	IIREMENTS	
	· · · · · · ·	3	<b>6</b>
ANT HEED (AND E (DEE)	RECOVERY	IT.RECOVERED/CYCLE	AMT LOST CYCLE
TYPE AMT. USED/CYCLE(REF)	FACTOR	① X ② (LB)	①-③ (LB)
WATER :5 (236)	N/A	N/A	.5
WATER LOSS TO .OZS	N/A _	NA	.025
SPACE			
		<b>5</b> ~	
Σ 0525		$\sum \emptyset$	525
The control of the co			* * * * * * * * * * * * * * * * * * * *
MISSION 40 x ZO.5 x	.525 - 430.	5 + N/A .	195.3 (430.5)
CYCLE/DAY DAYS/MISSION TO	TAL LOST/CYCLE (LB)	(z (1)	KG (LB)

HABITABILITY SUBSYSTEM_	2.0	Personal Hygiene
HABITABILITY FUNCTION	2.2	Body Cleansing
APPLIANCE FUNCTION	2.2.3	Partial Body Drying
NUMBER OF CONCEPTS CONS	I DERED_	3

#### **ASSUMPTIONS**

- (1) The wipes and towels considered for partial body drying provide the means for drying local body areas after partial body washing.
- (2) Washer/dryer penalty was based on washer Concept 7, Water Spray Agitation, and dryer Concept 1, Forced Hot Air-Electric Dryer.
- (3) Vacuum drying, if used, assumes the residual water in the item to be dried is lost to space. Cabin air loss is also computed, since the chamber contains a finite amount of cabin air prior to pump down.

B2-239

Sheathfull-like all helps was been as a second

APPLIANCE
CONCEPT
NO. CONCEPT NAME

REUSABLE DRY WIPES
DISPOSABLE DRY WIPES

ELECTRIC DRYER

PAUL IT.

CONCEPT NUMBER

Partial Body Drying (Shuttle) Concept Trade

2.

185

0

7

B2-242

APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 2.2.3-PARTIAL BODY DRYING

				Νl	Ј М В	E R	0	F	C O	мРО	N E	N T S	5		•	•	
COMPONENT 1	MOTOR	BLOWER	CONTROLLER	(Д) НЕАТЕR													NUMBER OF SAFETY CRITICAL ITEMS
APPLIANCE TYPE	NO. 1	(18)	19	17	0	0	0	0	0	0	0	0	0	0	0	0	112.13
REUSABLE DRY WIPES	-	-	-	-							-						0
DISPOSABLE DRY WIPES ELECTRIC DRIER	1	1	1	- 1											1 1 1 L		0
																	•
													-				
				• , ,													
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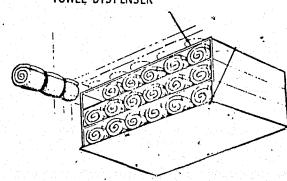
D2-118561-2

SPACECRAFT	Shu	ttle	<u>.</u>			
HABITABIL	ITY SUBSYSTEM Persona	l Hygiene	HABITABILIT	Y FUNCTION	Body Cleansi	ng
APPLIANCE	FUNCTION Partial B	ody Drying				
APPLIANCE	CONCEPT NO./TITLE_	1/Reusab	le Dry Wipes	•		·
INDEX NO.	2.2.3.1		_REF. NO	236,250		

#### DESCRIPTION

The reusable dry wipe concept consists of wipes made of terrycloth. The terrycloth wipes are 15 x 30 inches and are used 10 times per day before washing. The concept includes the weight and volume of the wipe dispenser. The towels are washed and dried after one day of usage and are discarded after 60 washings. The concept is penalized for the washer/dryer function required to recycle the wipes. The terrycloth wipes are smaller and lighter than the terry towels used for whole body drying after showering.

TOWEL DISPENSER



# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT ## CONCEPT

INDEX NUMBER 2.2.3.1

i en			AC . POWE	R	D C	POWER	75
COMPONENT (REF)	USE TIME CYCLE (HR)	PEAK (WATTS)	AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) ① X ③		⑥ AVERAGE (WATTS)	(7) DEMANI (WATT-HE CYCLE) ① X ⑦
		•				•	
		MAXIMUM.		TOTAL I	MUMIXAN		TOTAL
							<b>!</b>
	ŢΉ	ERMAL	REQUIE	REMENTS		•	
SOURCE		LATENT (BTU/HR)		SIBLE J/HR)	HEAT LEAK (BTU/HR)		OOLANT U/HR)
-N/A-		•	<u> </u>			<u>.</u>	•
	OTAL		entri en <del>entri e</del> ntri entri entre entri entre e	· · · ·	•		
	WA	TT (BTU/HF •	X) WATT (	BTU/HR) W	ATT (BTU/HR)	WATT	(BTU/HR)
		•					
	<u>o P</u>	<u>E R A T I</u>	ONAL PE	NALIIES			
SOURCE.	HEAT LE (B1U/HR/CY	TATERMA AK CLE)	AL TO COOLANT (BTU/HR/CYCLE)	ELECTRICAL (PK WATTS/CYCLE)	WEIGHT (LB/MISSION		OLUME MISSION
WASHETZ	630	<u>.</u>		29.7	<u> 25.1</u>		.245
DRYER			84.7	37.5			2
10	198 TAL <u>(67.5</u> WATTS/0 (BTU/IIR/	75)	24.8 (84.7) WATTS/CYCLE (BTU/HR/CYCLE)	67.2	/5.9 (35.1) kg/HISSION (LB/MISSION	(4:	/26 145) hission mission

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT // REUSABLE DRY WIPES

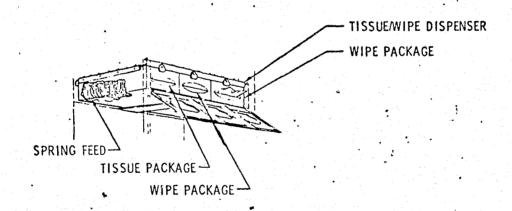
INDEX NUMBER 2.2.3.1

DISPENSER WIRES (REUSABLE	(REF) (236) (236)	(LBS) .7/6 .121		VOLUME (FT3) 632 05
WIRES (REUSABLE	<u>:) (236)</u> 	.121		05
			-	
		•		
				<del></del>
	<del></del>			
	. *		· · · · · · · · · · · · · · · · · · ·	
	<del></del>		· · · · · · · · · · · · · · · · · · ·	•
	TOTAL	.380 (.837)	.019	(.682)
		KG (LBS)		3 (FT ³ )
<u>S O L 1 D</u>	EXPENDA		UIREMENTS	_
4	WT/UI	② . ③ NT (REF) WT/CYCLE	(4) VOL/UNIT (REF)	(5) VOL/CYCLE
TYPE UNITS/CYC	ソ (PKG.WT	/UNIT)(REF) ①X② (LB). (LB)	VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT ³ )	① X ④ (FT³)
REUSABLE WIRES .016			.00366(236)	
•				
-				•
	<del></del>	<del></del>		<del></del>
				<del></del>
		Σ3 .000148	Σ⑤	0000008
		TOTAL WT/CYCLE  · (LB)	<b>∠</b> ⊍.	TOTAL VOL/CYCLE (FT3)
OTAL WT.				(۲(*)
OTAL WT. = 40 MISSION CYCLES/DAY	X 20.5 DAYS/MISS	ON TOT. WT/CYCLE	.055	(121)
	5,1,5,11,55,	(LB)		, (20)
OTAL VOL = 40	x 20.5	x -0000608 '	.0014	- 605)
CYCLES/DAY	DAYS/MISSI	ON TOT. VOL/CYCLE  (FT3)	М	(FT)
GAS/L	TOUID E		IREMENIS	
· · · · · · · · · · · · · · · · · · ·	0	RECOVERY AMT	.RECOVERED/CYCLE	AMT LOST/CYCLE
TYPE	MT.USED/CYCLE(REI	FACTOR	①x② (LB)	①-③ (LB)
WASHER WATER	6:9		N/A	6.9
LOSS PENALTY				
		<del> </del>		
		<del>.</del>		
		<del></del>	<del></del>	
Σ①	6.9		Σ @	4.9
20 -			<b>2</b>	_811
OTAL WT. 40 X	ZO.5	6.9 . 5658	1//0 - [-	,566 (5658)

SPACECRAFT	Γ <u>'Sh</u>	uttle	
HABITABIL	ITY SUBSYSTEM Person	al Hygiene HABITABILI	TY FUNCTION Body Cleansing
APPLIANCE	FUNCTION Partial	Body Drying	
APPLIANCE	CONCEPT NO./TITLE	2/Disposable Dry Wip	Des
INDEX NO.	2.2.3.2	REF. NO.	236

#### DESCRIPTION

The disposable dry wipe concept consists of wipes made of 4 ply "wet strength" paper. The paper wipes are 12 x 18 inches and are discarded after two uses. The wipe usage is based on 10 times per day per man. The wipes are disposed of by depositing into a vacuum drier to remove excess water. The dried wipe is then deposited into the refuse system. The concept includes the weight and volume of the wipe dispenser.



,						•
CONCEPT Z DISPOSABL	E Dey U	CE CONCEPT REQUIRES	MENTS AND PE	INALTIES CALC	JLATIONS INDEX N	UMBER 2.2.3.2
	ELECI	RICAL PO	WER F	REQUIRE	<u>H E N T S</u>	•
•	•	A C	POWER	<u> </u>	D C	POWER
COMPONENT (REF)	USE TIME CYCLE (HR)	(WATTS)	③ AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) ① X ③	⑤ PEAK (WATTS)	6 DEMAS AVERAGE (WATT-I CYCLE (WATTS) ①X(
N/A ·						
	4	-	and and specific	A PARA		TOTA
		MAXIMUM	•	TOTAL	MAXIMUM	TOTA
		<u>THERMAL</u>	<u>R E Q U I R</u>	<u>E M E N T S</u>		
SOURCE		LATENT (BTU/HR)	SENSI (BTU)		HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/A			•	**************************************		
			,			
	TOTAL	WATT (BTU/HR)	WATT (E	TU/HR)	WATT (BTU/HR)	WATT (BTU/HR
	<u>0</u>	PERATIONA	<u>L PE</u> !	N A L T I E S		
SOURCE	HEAT (BTU/HR,	THERMAL LEAK TO C YCYCLE) (BTU/H	OOLANT R/CYCLE)	ELECTRICAL (PK WATTS/CY	WEIGHT CLE) (LB/MISSIC	VOLUME ON) (FT ³ /MISSION
N/A						
	(BTU/	S/GYCLE WATT HR/CYCLE) (BTU/	S/CYCLE HR/CYCLE)		KG/MISSIC (LB/MISSIC	ON M ³ /M15510N (FT ³ /M15510N

#### APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED) CONCEPT 2/DISPOSABLE DRY WIPES

INDEX NUMBER 2, 2, 3, 2 WEIGHT/YOLUME WEIGHT (LBS) COMPONENT ·(REF) DISPENSER

> 10.3 TOTAL KG (LBS)

#### WI/VOL REQUIREMENTS EXPENDABLE <u>S Q L 1 D</u>

TYPE DISPOSABLE WIPE	① UNITS/CYCLE(REF) S .5 (236)	WT/UNIT (REF) (PKG. WT/UNIT) (REF) (LB).	. 3 wt/cycle ①x② (LB) _0/142	VOL/UNIT (REF) (PKG.VOL/UNIT)(REF) (FT ³ )	VOL/CYCLE ① X ④ (F1³)
•					
			•		
		Σ3	.01142	· Σ ⑤	.001142

TOTAL WT/CYCLE
· (LB)

#### GAS/LIQUID EXPENDABLES REQUIREMENTS

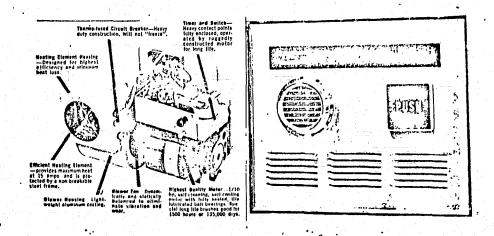
TYPE WATER LOSS DUE	AMT. USED/CYCLE (REF) (LB)  0245 (236)	RECOVERY FACTOR N/A	AMT.RECOVERED/CYCLE ① X ② (LB)	AMT LOST/CYCLE ①-③ (LB) .0245
TO VACUUM DEYING CABIN AIR LOSS	.00072 (234)	N/A:	N/A	.00072
$\Sigma$ ①	.02522		Σ٠	.02522

(LB) (z (1)

SPACECRAFT	'Sh	uttle	•		
HABITABILITY S	SUBSYSTEM Person	al Hygiene	_HABITABILITY	FUNCTION Body	Cleansing
APPLIANCE FUNC	CTION Partial	Body Drying	<i>,</i>	1	
APPLIANCE CONC	CEPT NO./TITLE_	3/Electri	c Dryer		
INDEX NO.	2.2.3.3	· · · · · · · · · · · · · · · · · · ·	_REF. NO. E1	ectric-Air Corp	•
			•	•	

#### DESCRIPTION

The electric dryer concept is identical to the terrestrial type used in restrooms. The concept incorporates a fan for blowing warm-dry air on the local body areas requiring drying. A nozzle is provided which can be used to direct the air stream. The concept does not require wipes for drying. A large "button" switch is provided for ease of actuation and the unit uses a timer to automatically turn off the unit after 40 seconds of operation. The automatic shutdown is incorporated to save power.



CONCEPT 3/ELECTRIC. DISSER

INDEX NUMBER 2.2.3.3

M3/MISSION (FT3/MISSION)

KG/MISSION (LB/MISSION)

					14 P M W C .	
	FFFF.	IRICAL PI AC		B E Q U I B E	D C .	POWER
COMPONENT (REF)  HENTER   MOTOL (ELL GILL	USE TIME CYCLE (HR)  JPC .O!!	PEAK (WATTS)	3 AVERAGE (HATTS) 1725	DEMAND (WATT-HR/ CYCLE) ① X ③	⑤ PEAK	© DEMANO AVERAGE (WATT-HR CYCLE) (WATTS) ① X ②
	•	1725.		18.9		7071
	-	MAXIMUM	•	TOTAL	MAXIMUM	TOTAL
	•	THERMAL		EMENTS		
SOURCE		LATENT (BTU/HR)		IBLE /HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
HENTER   MOTORS		•		61	261	
	• •					
	TOTAL			(261)	76,5861)	
		WATT (BTU/HR)	WAIT (	BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)
		<u>OPERATION</u>	AL PE	NALTIES		
SOURCE.	HEA (BTU/HR	THERMAL T LEAK TO (/CYCLE) (BTU/	COOLANT HR/CYCLE)	ELECTRICAL (PK WATTS/CY		VOLUME N) (FT ³ /M1SS10N)
				*	•	
<b>X</b>						

B2-251

WATTS/CYCLE (BTU/HR/CYCLE)

WATTS/CYCLE
... (BTU/HR/CYCLE)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT_3/ELECTRIC DRYGR

INDEX NUMBER 2.2.3.3

COMPONENT	•(REF)		WEIGHT (LBS)		y	OLUME FT³)
	PER ASSY LEWISH	eic-)	16	:		53
(v	GIR CO	rp)				
			<del>,</del>	-	• .	
		• • •		<del></del> .		
				<u> </u>		•
					•	•
				<del></del> -		
	TOTAL	1	7.26 (16		.015	(.53)
		• baindanian	KG (LBS)	ا لسبک		(FT ³ ) .
		•	•			
		ENDABLE (2)		QUIREM		<u>(S)</u>
teres de la companya	0	WT/UNIT (REF) (PKG.WT/UNIT)(RE	WI/CYCLE	VOL/UN	<pre> () () () () () () () () () () () () ()</pre>	VOL/CYCLE
TYPE	UNITS/CYCLE(REF)	(LB).	(LB)	(F	13)	① X ④ (FT³)
-N/A-						
			<del></del>		<del></del>	
		-			<u> </u>	
			——————————————————————————————————————	<del></del>		
		Σ	<u></u>		Σ⑤_	
			TOTAL WT/CYCL	E	(	TOTAL VOL/CYCLE (FT3)
TOTAL WT. =	Y	<b>Y</b> .	•	•		
CYC	CLES/DAY DAY	YS/MISSION	TOT.WT/CYCLE (LB)	(	KG	(LB)
TOTAL VOL _						
MISSION	CLES/DAY X DAY	YS/MISSION X	TOT. VOL/CYCLE	- !	M ₃	(F1³) .
			(FT ³ )			
the state of the s	<u>6 A S/L I Q U I D</u>	EXPEND		QUIREME!		
	•	D	<b>②</b>	AMT. RECOVERED	/CYCLE	MT LOST/CYCLE
	\$100 HOCO (A)		RECOVERY	A	CIULL	MIL COSTACIONE
ТҮРЕ	AMT.USED/C	YCLE(REF)	RECOVERY FACTOR	① X ② (LB)	,01026	①-③ (LB)
	. AMT.USED/C	YCLE(REF)	RECOVERT	① X ② (LB)		O-3 (LB)
	. AMT.USED/C	YCLE(REF)	RECOVERT	ŰXØ (LB)	,0000	(LB)
	. AMT.USED/C	YCLE(REF)	RECOVERT	①x② (LB)		(LB)
	. AMT.USED/C	YCLE(REF)	RECOVERT	①X② (LB)		(LB)
-N/A-	AMT.USED/C' (LI	YCLE(REF)	RECOVERT	①x② (LB)		(LB)
TYPE N/A	. AMT.USED/C	YCLE(REF)	RECOVERT	①x② (LB)	Σ @	(LB)

# D2-118561:2

HABITABILITY SUBSYSTEM 2.0	Personal Hygiene	•
HABITABILITY FUNCTION 2.3	Personal Grooming	<del></del>
APPLIANCE FUNCTION 2.3.1	Shaving	
NUMBER OF CONCEPTS CONSIDERED	5	

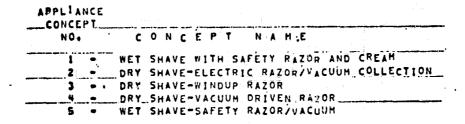
#### **ASSUMPTIONS**

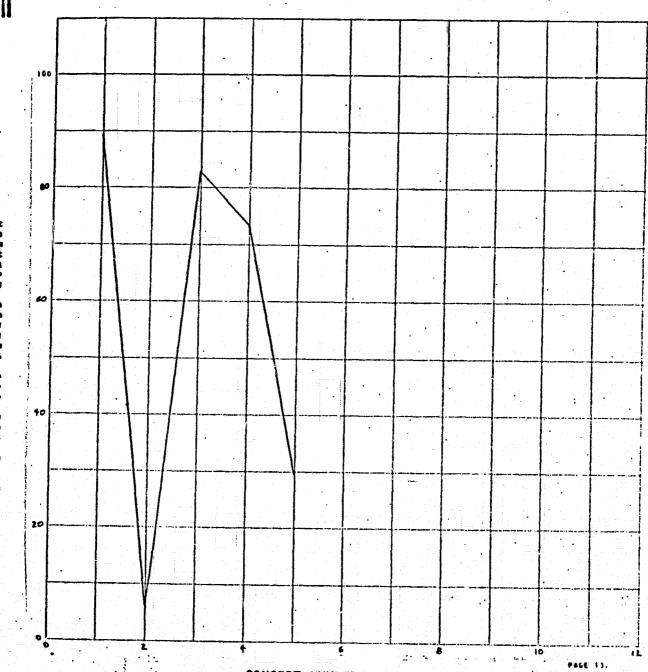
- (1) The shaving concepts are mechanical, electric, and vacuum operated with methods incorporated to retrieve cut hair particles to prevent cabin contamination.
- (2) The study assumed one shave per day per man.
- (3) Shaving is assumed to take 6 minutes per shave (236).

				APP	LIANCE C	ONCEPT	FUNC	TION MATE			. ——			
INDEX	NO. 2.3.	1++++SHA	ATME (2HAT	ILE)										
COHCEP	T USAGE TIME	CONSUMABL	ES AND FLO					REUNTS		R REGHTS	WT/VOL R	E9HTS 0	EVELOPHENT COST	RESUPPL
		AHT.  TYPE USED  (*) -KG/US	FLOW_	PRESS	TEMP	COOLA	NT	HT.LEAK_	PK PHR	AVG PAR		OLUME	VAIL LINDE	#EIGHT
		4La/US		(PSIG)	(DEG F) .	HVUTH)		8TU/HK}	-WATES-					(L _B S)
	9.600-						· · ·	6•			1.0	• GU		
	•100			1 - /			•••	( 0.)	•0 	••	( 2+1) (	•06}		.0
<b></b>	4.000	1 • 000 000 • • • • • • • • • • • • • • •	0 4.72 6)( 10.00)	•0 	21+1	_	) <del>(</del> ; • }	12.	:30•0 115•⊕ :	30•a •o	2+2 {4+7}- (	•01 •42)		•0 •••••••
						_	) •	o•	•0	-			-00-	•0
	•100						) • ) 		<u> </u>	•0		•02) •00		•0
	4.000 	1 •000	0 21•71 3)( 46•60)	( •0)	21+1 (-70+0)	. ( )	) • , • } :	{ 0•}	- • • • • • • • • • • • • • • • • • • •	.' •0	( = +2 ( = +4)(			
<u> </u>	4.000 •100	f •000	0 4.72 0)[ 10.00)	( .0)	( 70.0)	( 0				30+0 •0		•10)		( •0
<del></del>	P1								(*) 1 - CAB 2 - CAB 3 - OXYI	IN <b>AIR</b> GEN	(CIRCULATED (LOST) (LOST) (CIRCULATED	, KG/HR , KG/HR	/SEC (FT ³ /MI (LB/HR) (LB/HR) (LB/HR)	
HO.	- net	O N C E P T Shave With Sai Shave—electri	FETS RAZOR	AND CREA	H ECIION				5 - WATI 6 - NIT 7 - NIT	ER Rogen Rogen	(LOST) (CIRCULATED (USED)	, KG/HR ), KG/HR , KG/HR	(LB/HR) (LB/HR) (LB/HR)	
	- DRY	SHAVE-WINDUP   SHAVE-VACUUM   SHAVE-SAFETY	RAZOR Uhiven kazi	or					8 - FREI 9 - WATI		(CIRCULATED (PROCESSED)	, KG/HR , KG/HR	(LB/HR) (LB/HR)	
						<u>유</u>			(**)A	VAILABLE	. •	(***)C(	OST I CATOR	
			<u> </u>		<b>_</b>				(1) AVAIL	ABLE		0	-25%	
			<u> </u>	<del>,</del>	<u>`</u>	<u> </u>		· .		OF THE ART DEVELOPMENT		_	-50% - <b>75%</b>	
					• •	-		And the second	(a) some		• •	30	-	
				•	KLITTYND	had			(4) EXTEN	SIVE DEV. 1	REQUIRED	75	-100%	

B2-254

### D2:118561-2





CONCEPT NUMBER

Shaving (Shuttle) Concept Trade

#### APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

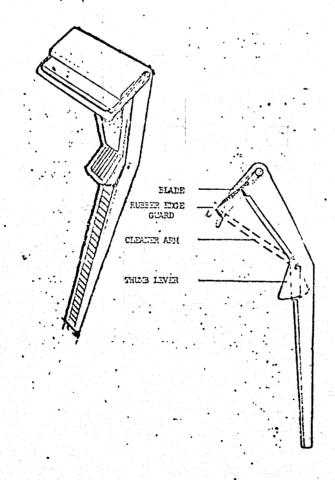
APPLIANCE FUNCTION: 2.3.1-SHAVING

				"N U	JMB	E R	0	F	C 0	мрс	NE	N T S	3				•
COMPONENT TYPE										l see		1, e e					NUMBER OF
	⊕ MOTOR										ere j	•					SAFETY CRITICAL ITEMS
PPLIANCE TYPE NO.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	TIENS
ET SHAVE WITH SAFETY RAZOR AND CREAM	-		•					•			:			:			0
RY SHAVE-ELECTRIC RAZOR/VACUUM COLLECTION	1																0
RY SHAVE-WINDUP RAZOR	1																. 0
RY SHAVE-VACUUM MOTOR-DRIVEN RAZOR	1	<b>.</b>															0
ET SHAVE-SAFETY RAZOR/VACUUM	-													·			0
		•				1								•			
							•								·		
				•								-					
													·				
											•						

SPACECRAFT	Shu1	tt]e	*			
HABITABILI	TY SUBSYSTEM Personal	l <u>Hygiene</u>	_HABITABILI	TY FUNCTIO	N <u>Personal</u>	Grooming
APPLIANCE	FUNCTION Shaving					
APPLIANCE	CONCEPT NO./TITLE	1/Wet Sha	ave-Safety R	azor and C	ream	
INDEX NO	2.3.1.1		REF. NO	236,207		
	. •				•	

#### **DESCRIPTION**

The safety razor and cream wet shaving concept consists of a safety razor and cream. The safety razor is an injector type and the shaving cream is contained in aerosol cans. The Skylab crew felt shaving cream should be dispensed using an aerosol can. The safety razor is provided with an arm which is actuated to remove the hair particles and cream prior to wiping the razor. One new blade is provided for every three days of usage. This concept was flown on Apollo.



CONCEPT / WET SHAVE - SAFETY ZAZOL & CREAM INDEX NUMBER 2.3.1.Z ELECTRICAL POWER REQUIREMENTS POWER POWER (4)
DEMAND
(WATT-HR/
CYCLE)
① X ③ (7)
DEMAND
(WATT-HR/
CYCLE)
(1) X (7) (3) 2 3 6 CYCLE PEAK AVERAGE PEAK AVERAGE COMPONENT (HR) (REF) (WATTS) (WATTS) (WATTS) (WATTS) 4. N/N. MUMIXAM TOTAL **MAXIMUM** TOTAL THERMAL REQUIREMENTS HEAT LEAK TO COOLANT LATENT SENSIBLE (BTU/HR) (BTU/HR) SOURCE (BTU/HR) (BTU/HR) NA TOTAL WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) <u>OPERATIONAL</u> PENALTIES THERMAL
TO COOLANT
(BTU/HR/CYCLE) ELECTRICAL. WEIGHT VOLUME HEAT LEAK (PK WATTS/CYCLE) (LB/MISSION) (FT3/MISSION) SOURCE (BTU/HR/CYCLE) NIA

> WATTS/CYCLE (BTU/HR/CYCLE) (BTU/HR/CYCLE) B2-260

WATTS/CYCLE

TOTAL

KG/MISSION (LB/MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

VE-SOFETY RAZOK AND CREAM

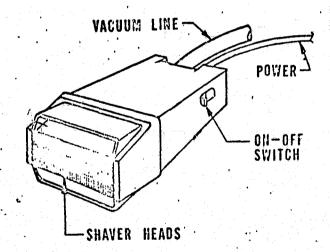
INDEX NUMBER 2.3.1.2 CONCEPT I WET SHAVE - SAFETY RAZOR AND CREAM

COMPONENT	(REF) (236)	WEIGHT (LBS) 46	, , .	VOLUME (FT ³ )
RAZOR/HOLDER BLADES		1.60		.043
	·			
	TOTAL [	.928 (2. <b>0</b> 46)	.00	23 (083) N ³ (FT ³ )
<u> </u>	<u>E X P E N D A B</u>	L <u>e wit/vol re</u> q	<u>UIREMENTS</u>	•
TYPE UNITS/CYCL BLACES 333 (	WT/UNIT (PKG.WT/U E(REF) (L	② . ③ (REF) WT/CYCLE NIT)(REF) ① X ② B). (LB)	(4) VOL/UNIT (REF) (PKG, VOL/UNIT) (REF) (FT3) 2001587 (234)	(5) VOL/CYCLE (1) X (4) (FT ³ )
		∑3 _0/957 TOTAL WT/CYCLE (LB)	Σ⑤	
MISSION CYCLES/DAY	x <u>20.5</u> DAYS/MISSION	X .01957 TOT.WT/CYCLE (LB)	.72	8 (1.60) KG (LB)
MISSION CYCLES/DAY	x <u>20.5</u> DAYS/MISSION	x .000,529 TOT.VOL/CYCLE (FT3)	.00	123 (.043) N ³ (FT ³ )
	• • • • • • • • • • • • • • • • • • •			
GAS/LI		ENDABLES REQU	1 R E M E N 1 S	<b>(</b>
TYPE AM	IT.USED/CYCLE(REF)	RECOVERY AMT FACTOR	T.RECOVERED/CYCLE ① X ② (LB)	AMT LOST/CYCLE  (LB)
			-	
Σ Φ _			Σ 🐠 🗆	
TOTAL WT X				<del> </del>

<b>SPA</b> CECRAFT	'Shuttle	•	22.2	
HABITABILITY SUBSYS	TEM Personal Hygier	e HABITABILIT	Y FUNCTION Per	rsonal Grooming
APPLIANCE FUNCTION_	Shaving			· · · · · · · · · · · · · · · · · · ·
APPLIANCE CONCEPT N	0./TITLE 2/Dry St	ave-Electric R	azor/Vacuum Co	ollection
INDEX NO. 2.3	.1.2	REF. NO	236,207	· · · · · · · · · · · · · · · · · · ·
•			•	

#### **DESCRIPTION**

The electric razor/vacuum collection dry shave concept consists of an electric razor with vacuum collection of the cut hair particles. The electric razor incorporates a hood to aid vacuum collection. The unit requires a vacuum for collection of the hair particles. The concept, therefore, is penalized for a vacuum unit based on operating time. The vacuum unit used is identical to the Skylab power module.



# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT 2/DRY SHAVE-ELECTRIC IRAZOR/VACUUM COLLECTION

INDEX NUMBER 2.3.1.2

	ELECIE	•		REQUIRE			
COMPONENT (REF)  RAZOL MOTOL (236)	USE YIME CYCLE (HR)	PEAK (WATTS)	O N E  AVERAGE (WATTS)  30	DEMAND (WATT-HR/ CYCLE) ① X ③  3.0	D C  B PEAK (WATTS)	POWER  6  AVERAGE (WATTS)	(7) DEMAND (WATT-HR CYCLE) ① X ②
		.30 .		3.0 TOTAL	MAXIMUM		TOTAL
							• • • • • • • • • • • • • • • • • • •
SOURCE		HERMAL  LATENT (BTU/HR)	SENS	REMENTS BIBLE N/HR)	HEAT LEAK (BTU/HR)		OOLANT U/HR)
PAZOR MOTOR					41		
TO	TAL 6	NATT (BTU/HR) .	/2 WATT (	(41) BTU/HR)	12 (41) WATT (BTU/HR)	WATT	(BTU/HR)
SOURCE.	O ! HEAT ( (BTU/HR/C		AL PE  COOLANT /HR/CYCLE)	NALTIE!	WEIGHT		LUME MISSION)
MODULE (SKYLAB)	40	2					oz .
TOTA	WATTS	CYCLE WAT	TTS/CYCLE I/HR/CYCLE)		.34 (Q) (.75) KG/MISSIC (LB/MISSIC	H M3/15	0057 02) 15510N M15510N)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT Z/DEY SHAVE-ELECTRIC RAZOR/VACUUM COLLECTION INDEX NUMBER 2.3.1.2

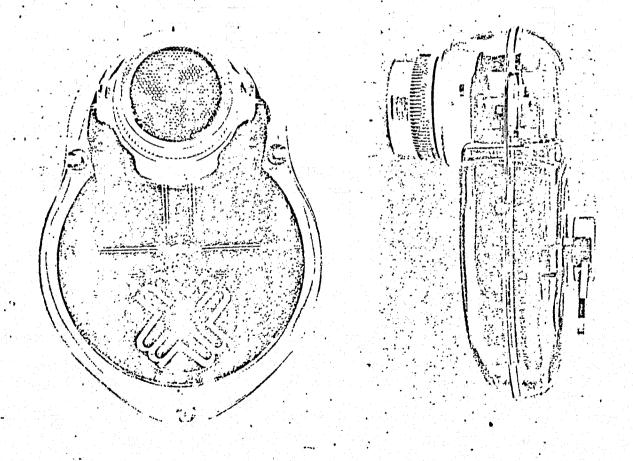
DMPONENT -	·(REF)	WEIGHT (LBS)	e de la companya de l	VOLUME (FT3)
PAZOR/HOW		4.0		.4
		*		r
			<u></u> '	<u> </u>
		• • • • • • • • • • • • • • • • • • • •		· · · · · · · · · · · · · · · · · · ·
			<del></del>	
			<del></del>	
	TOTAL.	1.8 (4.0		0113 (.4)
	•	KG (LBS)		M ³ (FT ³ ) .
		• * * * * * * * * * * * * * * * * * * *		
			REQUIREMENTS (4)	<b>(5)</b>
	① (PK	② ③  T/UNIT (REF) WT/CYCLI G.WT/UNIT)(REF) ① X ② (LB). (LB)	VOL/UNIT (REF (PKG.VOL/UNIT)(I (FT³)	S VOL/CYCLE REF) (1)X(4)
TYPE	UNITS/CYCLE(REF)	G.WT/UNIT)(REF) ①X② (LB), (LB)	(FT ³ )	(EF) ① X ④ (FT³)
N/A				
<del></del>				<u> </u>
	-			
1.				<u></u>
<del></del>		Σ③	Σ	TOTAL VOL/EYCL
		TOTAL WT/C	TOLE	(FT ³ )
TAL WT. =	X	<b>x</b>	•	
CYCI	ES/DAY DAYS/M	ISSION TOT.WT/CYCLE (LB)	-	KG (LB)
TAL VOL =				
WI2210M CACI	LES/DAY A DAYS/M	TOT.VOL/CYCL (IT3)	<u> </u>	M ³ (FT ³ )
	C A C// 1.0 H T.D	EXPENDABLES R	<u>EQUIREMENTS</u>	
	GAS/LIQUID	. ©		<b>6</b>
er en en er vitt. En en	AMT HISED/CYCLE		AMT.RECOVERED/CYCLE	AMT LOST/CYCL
TYPE	AMT. USED/CYCLE	FACTOR	①x② (LB)	①-③ (LB)
N/A			•	
-	· · · · · · · · · · · · · · · · · · ·			
	Σ.0		Σ @	<u> </u>
	Σ ①		<u> </u>	·
		· · · · · · · · · · · · · · · · · · ·		

## D2:118561-2

SPACECRAFT_	Shuttle			
HABITABILITY	SUBSYSTEM Personal Hygier	e HABITABILITY	FUNCTION Personal	Grooming
APPLIANCE FU	NCTION Shaving			
APPLIANCE CO	NCEPT NO./TITLE 3/Dry St	ave-Windup Razo	or (Skylab)	
INDEX NO	2.3.1.3	REF. NO	NASA JSC, G.E.	
			•	

#### **DESCRIPTION**

The windup razor dry shave concept consists of a mechanical windup motor shaver with a hair particle reservoir. The unit was used on Skylab and the weight and volume figures specified are for the flight weight unit.



ORIGINAL PAGE IS OF POOR QUALITY

	CONCEPT 3 DEM SHIVE	= - MINDA	NCE CONCEPT REQUIRED (S	KLY LAB)		INDEX NUM	DER 2.3.1.3
	<b>.</b> • •	ELECI	CRICAL !	OWER	REQUIRE	MENIS	• •
•		•	A (	. POWE		ОС	POWER
•	COMPONENT (REF)	USE TIME CYCLE (HR)	PEAK (WATTS)	AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) ① X ③		O DEM VERAGE (WATT- VALUE WATTS) ① X
•			***************************************				
•							
			MAXIMUM	•	TOTAL	MAXIMUN	тот
		•.		•	· ·		
		•	I H E R M A L	REQUI	<u>REMENIS</u>		
•	SOURCE		LATENT (BTU/HR)		SIBLE U/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
	· NA	•	· · · · · · · · · · · · · · · · · · ·				· · · · · · · · · · · · · · · · · · ·
				<del></del>	· · · · · · · · · · · · · · · · · · ·		<u> </u>
						-	
*		TOTAL	WATT (BTU/HR)	WATT	(BTU/HR)	WATT (BTU/HR)	WATT (RTU/H
		7-7-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1					
			OPERALLO!	LAL PE	NALIIE		
	SOURCE	HEA (BTU/HR	THERMAL T LEAK THE (BT)	COOLANT J/HR/CYCLE)	ELECTRICAL (PK WATTS/C		VOLUME (FT ³ /MISSIO
	<u> </u>						
•		TOTAL	TS/CYCLE W.	NITS/CYCLE	entre de reconstant l'apparent de l'Argentine de l'	KG/M15510N	M³/K1SS10N

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 3/ORY SHAVE - WINDUP PAROL (SKYLAB)

INDEX NUMBER 2.3.1.3

OMPONENT	·(REF)	•	WEIGHT (LBS)	• •	VOLUME (FT ³ )
PAZOR/HOLDER			<u>.977</u>	<u>, , , , , , , , , , , , , , , , , , , </u>	.0224
				3	
	<del></del>				
		1,			
•		************			
		· ·		<u> </u>	
,	TOTAL		43 (977)	.00	0063 (0224 M³ (FT³) ' ,
•		•	KG (LBS)	•	M* (F)*) ,
<u> </u>		NDABLE  ② WT/UNIT (REF) PKG.WT/UNIT)(REF	. ③ WT/CYCLE	L R E M E N I S  O  VOL/UNIT (REF)  (PKG. VOL/UNIT) (REF  (FT3)	VOL/CYCLE
TYPE UNITS/	CYCLE(REF)	(LB).	) ①x② (LB)	(FT ³ )	(FT ³ )
<u>'</u>			<del>-</del>		-
<u> </u>					-
					<u> </u>
		$\Sigma$ (		Σ (	-
		۷.	TOTAL WT/CYCLE · (LB)	20	TOTAL VOL/CYCLE (FT3)
OTAL WT. = MISSION =	x	X _	•		
CYCLES/DAY	DAYS	MISSION	TOT.WT/CYCLE (LB)		KG (LB)
OTAL VOL	X	/MISSION X	TOT.VOL/CYCLE		M³ (FT³)
CICLES/DAT	DATS	/1/1331011	(FT ³ )		
		EXPENDA	Bire DENII	<u>IREMENIS</u>	
, and Samura Section 2	₹\ <b>₽</b> 1₫¶1₽			.RECOVERED/CYCLE	MT LOST CYCLE
TYPE	AMT.USED/CYC	LE(REF)	RECOVERY AMT FACTOR	RECOVERED/CYCLE  ① X ②  (LB)	AMT LOST/CYCLE  (LB)
N//					
ΣΘ	)			ΣΦ	
1			•		

SPACECRAFT_	Shuttle			•
HABITABILIT	TY SUBSYSTEM Personal Hygiene	_HABITABILIT	Y FUNCTION_	Personal Grooming
APPLIANCE F	FUNCTION Shaving			
APPLIANCE (	CONCEPT NO./TITLE 4/Dry Shav	e-Vacuum Moto	or-Driven F	lazor
INDEX NO.	2.3.1.4	REF. NO	280	
DESCRIPTION				•
The vacuum motor with	motor-driven razor dry shave a hair particle reservoir. The motor runs on space vacu			

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS SHAVE-VACOUM MOTOR - DRIVED RAZOR INDEX NUMBER Z.3.1.4 ELECIRICAL POWER REQUIREMENTS POWER (4)
DEMAND
(WATT-HR/
CYCLE)
(1) X (3) (7)
DEMAND
(WATT-HR/
CYCLE)
① X ⑦ USE TIME 2 (3) (3) 6 AVERAGE CYCLE **AVERAGE** PEAK PEAK COMPONENT (HR) (WATTS) (WATTS) (WATTS) (REF) (WATTS) TOTAL MUMIXAM TOTAL MAXIMUM IHERMAL REQUIREMENTS . SENSIBLE HEAT LEAK TO COOLANT LATENT (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR) SOURCE TOTAL NATT (BTU/HR) MAST (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) <u>O P E R A T I O N A L</u> PENALTIES WEIGHT VOLUME ELECTRICAL HEAT LEAK TO COOLANT (LB/MISSION) (FT3/MISSION) SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) NA

5 2

TOTAL

WATTS/CYCLE (BTU/IIR/CYCLE)

WATTS/CYCLE (BTU/HR/CYCLE) KG/MISSION (LB/MISSION)

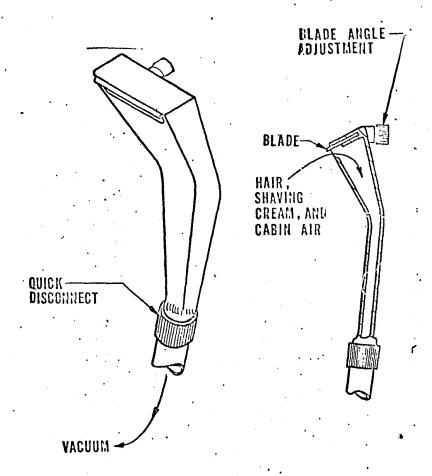
M³/MISSION (FT³/MISSION)

•	<u>F 1 X E D</u>	WEIGHT/VOLU	<u>ME REQU.IR</u>	<u> </u>	•
OMPONENT PAZOR/HOLD	(REF) (200)		WEIGHT (LBS) -37		VOLUME (FT ³ )
		•••			
	TOTAL	,	168 (.37)		0013 (004
			KG (LBS)		M ³ (FT ³ ) .
TYPE - N/A -	<u>SOLID</u> <u>EX</u>	PENDABLE  WIT/UNIT (REF) (PKG.WIT/UNIT)(REF) (LB).	W 1/V 0 L R E Q !  WT/CYCLE  ① X ②  (LB)	U I R E M E N I S  VOL/UNIT (REF (PKG. VOL/UNIT)( (FT3)	<b>(S)</b>
. ,					
•		Σ3	TOTAL WT/CYCLE  (LB)	Σ.	TOTAL VOL/CYC
TAL WT. ITSSION = CYC	LES/DAY X	XYS/MISSION X	TOT.WT/CYCLE (LB)		KG (LB)
TAL_VOL =			, ,	• •	· ·

# TYPE AMT. USED/CYCLE (REF) RECOVERY FACTOR AMT. RECOVERED/CYCLE AMT. RECOVERED/CYCLE (LB) 
SPACECRAFT		<u>Shuttle</u>	<del>_</del>		
<b>HABIT</b> ABILI	TY SUBSYSTEM Pers	onal Hygiene	_HABITABILI	TY FUNCTION <u>Pers</u>	onal Grooming
APPLIANCE	FUNCTION Shavir	19			
APPLIANCE	CONCEPT NO./TITL	E <u>5/Wet Shave-</u>	Safety Razo	r/Vacuum Collect	ion
INDEX NO	2.3.1.5		REF. NO	236,206	

#### **DESCRIPTION**

The wet shave safety razor/vacuum collection concept consists of the same razor described in Concept 1 with the addition of vacuum collection. The vacuum unit used is identical to the Skylab power module. The concept is penalized for a vacuum unit based on operating time.



CONCEPT SHOVE-SAFETY RIZER / VACUUM COLLECTION INDEX NUMBER 2.3.1.5

THERMAL REQUIREMENTS  LATENT SENSIBLE HEAT LEAK TO COOLANT SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR)  TOTAL  MATT (BTU/HR)  DPERATIONAL PENALTIES  HEAT LEAK TO COOLANT ELECTRICAL MEIGHT VOLUME		•		A C	POWE	R	D C	POWER
TOTAL  LATENT SENSIBLE HEAT LEAK TO COOLANT SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR)  MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  PRESON MOTOR  DEERALLONAL PENALLIES  HEAT LEAK TO COOLANT TO COOLANT TO COOLANT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (LE/MISSION) (FT ³ /MISSION)  MACLIUM POWER 40 1/5 .02			CYCLE	PEAK . (WATTS)	AVERAGE (WATTS)	(WATT-HR/ CYCLE) ①X③	PEAK A	VERAGE (WATT-
TOTAL  SOURCE  LATENT SOURCE  LATENT SOURCE  (BTU/HR)  TOTAL  TOTAL  TOTAL  TOTAL  ATT (BTU/HR)  PENALTIES  WEIGHT  WATT (BTU/HR)  LATENTAL  (BTU/HR)  TOTAL  TOTAL  ATT (BTU/HR)  MATT (BTU/HR)  WATT (BTU/HR)  NATT (BTU/HR)		RAZOR MOTER (236)		<u> 30</u>	30_	3.0		
THERMAL REQUIREMENTS  LATENT SENSIBLE HEAT LEAK TO COOLANT SOURCE (BTU/HR) (BTU/HR) (BTU/HR)  TOTAL  ATT 41  PERSON MOTOR  PERATIONAL PENALTIES  NATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  NATT (BTU/HR)  TO COOLANT SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (LB/MISSION) (FT³/MISSION)  MAXIMUM TOTAL MAXIMUM TOTAL  TO COOLANT SELECTRICAL MEIGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK MATTS/CYCLE) (LB/MISSION) (FT³/MISSION)	• •				•	***************************************		
I HERMAL REQUIREMENTS  LATENT SENSIBLE HEAT LEAK TO COOLANT SOURCE (GTU/HR) (BTU/HR) (BTU/HR)  MATT (BTU/HR) MATT (BTU/HR) MATT (BTU/HR)  DPERATIONAL PENALTIES  HEAT LEAK TO COOLANT ELECTRICAL MEIGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK MATTS/CYCLE) (LB/MISSION) (FT3/MISSION)  MACCIUMIN POWER 40 1/5 .75 .02								
SOURCE (BTU/HR) SENSIBLE HEAT LEAK TO COOLANT TOTAL  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME (BTU/HR/CYCLE) (BTU/HR/CYCLE) (BTU/HR/CYCLE) (FF3/MISSION) (FF3/MISSION)  VACUUM POWER 40 - 1/5 .75 .02	•		•		•		MUMIXAM	ATOT .
SOURCE (BTU/HR) SENSIBLE HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME SOURCE (BTU/HR/CYCLE) (BTU/HR/CYCLE) (FF3/MISSION) (FF3/MISSION)  LATENT SENSIBLE HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME (BTU/HR)  ***TOTAL**  ***DPERATIONAL**  ***DPERATIONAL**  ***DEMALTIES**  ***TO COOLANT**  ***SOURCE**  ***(BTU/HR/CYCLE)*  ***(BTU/HR/CYCLE)*  ***COUNTY POWER**  ***TO COOLANT**  ***ELECTRICAL**  ***MEGHT**  ***VOLUME**  ***(FF3/MISSION)*  ***YACCUMA POWER**  ***TO COOLANT**  ***SOURCE**  ***(BTU/HR/CYCLE)*  ***(BTU/HR/CYCLE)*  ***(BTU/HR/CYCLE)*  ***TO COOLANT**  ***COUNTY POWER**  ***TO COOLANT**  ***SOURCE**  ***(BTU/HR/CYCLE)*  ***(BTU/HR/CYCLE)*  ***(BTU/HR/CYCLE)*  ***TO COOLANT**  ***SOURCE**  ***TO COOLANT**  ***SOURCE**  ***(BTU/HR/CYCLE)*  ***(BTU/HR/CYCLE)*  ***(BTU/HR/CYCLE)*  ***TO COOLANT**  ***TO COOLANT**  ***TO COOLANT**  ***SOURCE**  ***(BTU/HR/CYCLE)*  ***(BTU/HR/CYCLE)*  ***(BTU/HR/CYCLE)*  ***TO COOLANT**  **TO COOLANT**  ***TO COOLANT**  ***TO COOLANT**  **TO COOLANT**	•	• •		•	•	:		
SOURCE (BTU/HR) (BTU/HR) (BTU/HR) (BTU/HR)  RAZOR MOTOR  TOTAL  JZ (#1)  WATT (BTU/HR)  VOLUME  (BTU/HR/CYCLE)  (BTU/HR/CYCLE)  (BTU/HR/CYCLE)  (BTU/HR/CYCLE)  WEIGHT  VOLUME  (BTU/HR/CYCLE)  (BTU/HR/CYCLE)  (BTU/HR/CYCLE)  (BTU/HR/CYCLE)  VACCUMEN POWER  40  1/5  75  02	•		· .	I H E R M A L	<u>R E Q U I R</u>	EMENIS		•
TOTAL    12 (41)   12 (41)     MATT (BTU/HR)   WATT (BTU/HR)   WATT (BTU/HR)   WATT (BTU/HR)     MATT (BTU/HR)   WATT (BTU	¥	SOURCE	· ·		•			
TOTAL    12 (41)   12 (41)   WATT (BTU/HR)   WATT (BTU/HR)   WATT (BTU/HR)   WATT (BTU/HR)   WATT (BTU/HR)		RAZOR MOTOR			4	·/	_41	ن به المستقدية المستقدمة المستقدم المست
TOTAL    12 (41)   12 (41)   MATT (BTU/HR)   WATT (BTU/HR)   WATT (BTU/HR)   WATT (BTU/HR)    OPERATIONAL   PENALLIES				•		•		
TOTAL    12 (41)   12 (41)     WATT (BTU/HR)   WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WATT (BTU/HR)     WATT (BTU/HR)   WAT				•	•			
DPERATIONAL PENALTIES  THERMAL  HEAT LEAK  TO COOLANT  SOURCE.  (BTU/HR/CYCLE)  (BTU/HR/CYCLE)  (PK WATTS/CYCLE)  (LB/M1SS1ON)  (FT3/M1SS1ON)  VACUUM POWER  40  115  75  02		•	FOTAL			<del></del>		
THERMAL  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME  (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISSION)  VACUUM POWER 40 - 1/5 .75 .02				WATT (BTU/HR)	WATT_(	BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR
THERMAL  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME  (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISSION)  VACUUM POWER 40 - 1/5 .75 .02			•	•	· .		• • • <del>-</del> • • • •	•
THERMAL  HEAT LEAK TO COOLANT ELECTRICAL WEIGHT VOLUME  (BTU/HR/CYCLE) (BTU/HR/CYCLE) (PK WATTS/CYCLE) (LB/MISSION) (FT³/MISSION)  VACUUM POWER 40 - 1/5 .75 .02			•	<b>OPFRATIO</b>		NAITIFS	•	•
		SOURCE.	HE (BTU/H	THERMAL AT LEAK TO	) COOLANT	ELECTRICAL	WEIGHT	
				40		_115_	.75	
	•	<b>)</b>						
. 11.7 .34 .00057		то	TAL	40)	TTS/CYCLE		(15) (.75)  KG/MISSION (LB/MISSION)	(, OZ) M³/M15510H (FT³/M15510H

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT STATES PARTY RAZOR/VACUUM COLLECTION INDEX NUMBER 2.3.1.5

	:	(nee)	•	WEIGHT				VOLUME
OMPONENT BAZOR/HOU	DER	(REF) (236)		(LBS)	, <del>,</del>			(FT ³ )
BLADES		(236)		1.60	••			043
			-	•			•	
		•	, <u></u>			•		
		,	<u></u>	<del></del>				
		·	٠				•	
			,		6 246)	ĺ		
. ,		TOTAL	. L	. 928 KG (LBS)	(2.046)   )		.00	123 (083) 13 (FT3) .
٠,			••					•
	<u>s o L 1 D</u>		N D A B L (2)		<u>L REQU</u> 3	JIREM	_	( <del>S</del> )
	. 0	) (	WT/UNIT (R PKG.WT/UNIT	EF) WT	T/CYCLE 1) X (2)	VOL/UN (PKG.VOL	(4) IT (REF) /UNIT)(REF)	VOL/CÝCLE ①X ④ (FT³)
TYPE BLADES	UNITS/CYC .333	LE(REF)	(LB). 0587.		(LB) 1957	(1	^{†3} ) 1587/236	
BCHUCS		_ <del>(حی)</del>						
<b>.</b>								·
		-			•			•
			<del></del>					
			•	Σ3 _0	1957 L WT/CYCLE (LB)	-	$\Sigma$ (5)	TOTAL VOL/CYCLE (FT3)
OTAL WT. =	4	v 2	0.5	v 0/		2	.72	
CYC	LES/DAY	DAYS	O.S MISSION	TOT.WT/ (LL	/CYCLE		1	(G (LB)
OTAL_VOL =	1	v 2/	0.5		1529 :		.00/	23 (043)
CYC	LES/DAY		MISSION	TOT.VOL	L/CYCLE T³)			(F) (F) E)
	,			,	' <i>'</i> .		•	
	G A S/L	<u> 1 Q U 1 D</u>	EXPE	<u>N D A B L E S</u>	R E Q U	IREME	N T S	
		①			•	3	*	AMT LOST/CYCLE
		MT HISED/CYC	LE(REF)	RECOVERY	AMT.	RECOVEREI (D X (D (LB)	/CYCLE	AMT LOST/CYCLE ①-③ (LB)
TYPE -1/14 -		, (LB)		FACTOR		(LB)		(L8)
				1				
	·				<del></del>			
			•					
·	·		· · · · · · · · · · · · · · · · · · ·	enderstand on the time		<del></del>	<u>'C</u>	
<u> </u>	$\Sigma$ ① .	<del></del>		٠,		•	ΣΦ_	
			,					

HABITABILITY SUBSYSTEM 2.0	Personal Hygiene
HABITABILITY FUNCTION 2.3	Personal Grooming
APPLIANCE FUNCTION 2.3.2	Hair Cutting .
NUMBER OF CONCEPTS CONSIDERED	2

#### **ASSUMPTIONS**

- (1) The hair cutting concepts are mechanical and electrically operated with methods incorporated to retrieve cut hair particles to prevent cabin contamination.
- (2) The study assumed one haircut every 14 days for Concept 1 and every 7 days for Concept 2.
- (3) Hair cutting is assumed to take 15 minutes for Concept 1 and 5 minutes for Concept 2 per haircut.

INDE	X NO.	2.3.2		, HAIR	CUTTING	<b>(</b> \$#U	TTLE		·					•			* - *	· · ·	···		
CONCE NO.		SAGE.	CON	SUMABLES	_AND_FL	OW_RE	QUIREMEN	it§	THERM	AL.R	EQHTS_	EL	Ec PWR	REQUI	5WT)	VOL_R	9HTS		OPHENT OST	RESI	UPP <u>L</u>
	USE	S/DAY.	(+) -	·KG/USE=	•	⇒ Mi	MHGDE	MP (	WATTS		WATTS.	A1	c	DC	-K	G(	U H-	(**)	_[NDEX	-)	IGHT KG- LBS1
••••	****		•••••	•••••	•••••	•••••		******		••••	• • • • • •	•••••	•••••		• • • • •	• • • • •		•••••	•••••		••••
1_		•070 •077				<del></del> ;		,			33 114+1		0.0 5.0		( 2	• 9	 • 25		10	(	•0 •0
2		e 140 •203							0.	<b>}</b> (.	3• 11•)-	11	•0 5•0	•0	.( 1	• 7 • 5 ) (.	•01 •25	0	10		• 0 • 0
						<del></del>							· P · , up + 10 mm min	·~							
CONC NO	•	C_0	CLIPPE	P_IN	H COLLE	ECTION ION					3 4 5 7 8	- CABII - CABII - OXYGI - COOL - WATEI - NITRI - FREOI - WATEI	N AIR EN ING WAT! R OGEN OGEN N	(LOS) (LOS) ER (CIR) (LOS) (CIR) (USEI)	r) Culated () Culated	, KG/H , KG/H , KG/H , KG/H , KG/H	IR IR IR IR IR IR IR	(FT ³ /M (LB/HR (LB/HR (LB/HR (LB/HR (LB/HR (LB/HR (LB/HR (LB/HR	} } } }		
						$\sim$	ORIGINAL PACE				(1) — (2) _ (3)	AVAILA STATE (	AILABLE BLE OF THE / EVELOPME IVE DEV.	ART ENT REQU		<u>1</u>	0-25% 25-50% 50-75% 75-100	•			
						RE	1						·								
<del></del>		······································	·	<del></del>			<u> </u>						<u></u>								

_APPLIANC	E						
GONCEPT					•		
NO.	C	0 N	CE	P.T	N .A	M E	
	POWE	R_C	LIPE	ER/V	ACUUH	COLLEC	TION
2 -	RAZO	R C	OMB	VVACU	TH COF	LECTIO	N

CONCEPT NUMBER

Hair Cutting (Shuttle) Concept Trade

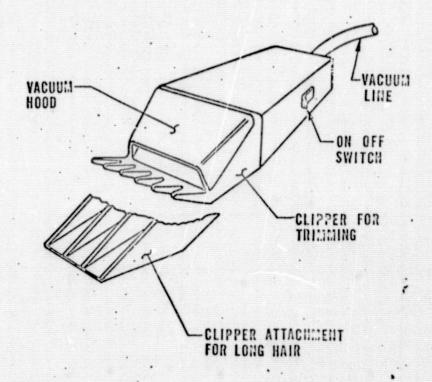
				NU	Ј М В	E R	0	F	C O	M P O	ΝE	N T S	;				
COMPONENT TYPE	•								•					-			NUMBER OF
APPLIANCE TYPE NO.	(I) MOTOR									-							SAFETY CRITICAL ITEMS
APPLIANCE TYPE NO.	(1)	0	$\circ$	Ò	0	0	$\bigcirc$	0	0	0	0	$\bigcirc$	<u>O</u>	0	0	0	
POWER CLIPPER/VACUUM COLLECTION RAZOS COMB/VACUUM COLLECTION	1 -														•		0
		٠					•									÷	
		·												٠			٠
												•			٠		
			-						-								-
•		,	•					•									
			, -			•	٠										
	· •																
	•		•	•													

D2:-118561*

SPACECRAFT	Shuttle	_		
HABITABILITY SUBS	YSTEM Personal Hygien	_HABITABILI	TY FUNCTION Personal	Grooming
APPLIANCE FUNCTIO	N Hair Cutting	<u> </u>		<u> </u>
APPLIANCE CONCEPT	NO./TITLE 1/Electr	ic Clipper/Va	cuum Collection	
INDEX NO2.	3.2.1	REF. NO	236,207	

#### DESCRIPTION

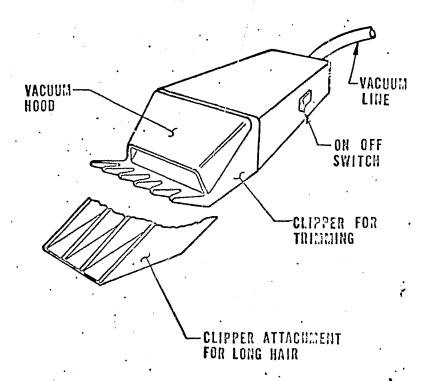
The electric clipper/vacuum collection concept consists of an electrically driven clipper with vacuum collection of the hair clippings. The clipper is similar to the terrestrial barber type. The unit used for vacuum collection is the power module used on Skylab. A hood is employed over the clipper area to assist in the pickup of the hair clippings.



SPACECRAFT	Shut	tle			•
HABITABILI	TY SUBSYSTEM Persor	al Hygiene	_HABITABILITY	FUNCTION <u>Personal</u>	Grooming
APPLIANCE	FUNCTION Hair Cut	ting	•		
APPLIANCE	CONCEPT NO./TITLE_	1/Electric	: Clipper/Vac	uum Collection	
INDEX NO	2.3.2.1		REF. NO	236,207	
					•

#### **DESCRIPTION**

The electric clipper/vacuum collection concept consists of an electrically driven clipper with vacuum collection of the hair clippings. The clipper is similar to the terrestrial barber type. The unit used for vacuum collection is the power module used on Skylab. A hood is employed over the clipper area to assist in the pickup of the hair clippings.



# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT / ELECTION

. . .

INDEX NUMBER 2.3.2.1

E	Ī	Ē	<u>C</u>	Ī	<u>R</u>	1	Ē	A	ŗ.	<u>P</u>		E	<u>R</u>	E	Q	U	1	R	<u>E</u>	M	<u>E</u>	M	Ţ	<u>s</u>

·	•			. PÓWE		<u>D</u>	C PO	WER (2)
COMPONENT	(REF)	USE TIME CYCLE (HR)	PEAK (WATTS)	③ AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) ① X ③	⑤ PEAK (WATTS)	⑥ AVERAG (WATTS	01000
MOTOR	(256)	14 ·	_50_	<u>50 ·</u>	_7		•	
· · · · · · · · · · · · · · · · · · ·			•					
<i>?</i> .								
	•	•	.50 .	•	. 7 .		•	· .
•			MAXIMUM		TOTAL	MAXIMUM	,	TOTAL
		•						
			THERMAL	<u>R E Q U 1 i</u>	REMENIS	•	•	• .
• : • <b>so</b> urc	Έ	.•	LATENȚ (BTU/HR)		SIPLE J/HR)	HEAT LEAK (BTU/HR)		TO COOLANT (BTU/HR)
MOTOR		236)		/	14	114	<del></del>	
				-				•
\		TOTAL		33.	7.(114)	33.4 (1)	 <del>2)</del>	
•			WATT (BTU/HR)	. WATT (	BTU/HR)	WATT (BTU/H	₹)	WATT (BTU/HR)
	•		•	•	•	•		•
٠., ١				•				
	•	•	OPERATIO	NAL PE	NALIIES		•	0
SOU	IRCE.	HEA (0 )/HI	THERMAL AT LEAK T R/CYCLE) (BT	O COOLANT U/HR/CYCLE)	ELECTRICAL (PK WATTS/CY			VOLUME (FT³/MISSION)
VACUUM			2.7	••			4	(neg)
MODULE	CSKYU	98)	• • • • • • • • • • • • • • • • • • •	·			•	
			•79	<del></del>	*	18		
•	<b>T</b>	OTAL WAT	2.7) TS/CYCLE L	ATTS/CYCLE	115 (	(x) (.0 KG/M1S (1.R/M1S	SION	(Meg) M3/M19SION (FT3/M19SION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

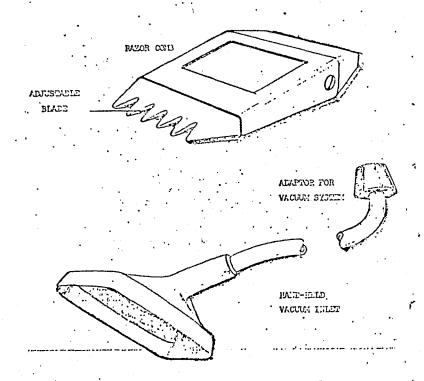
CONCEPT I/ELECTRIC CLIPPEX/VACUUM COLLECTION INDEX NUMBER 2.3.2.1

OMPONENT	7	(REF)	٠	WE]	GHT BS)			VOLUME (FT3)
CLIPPUR/HO	CDER	(236)			2.0		• • • • • • • • • • • • • • • • • • • •	.25
		· · · · · · · · · · · · · · · · · · ·		<del></del>		<del></del>		
					•	<del></del>		
				<del></del>	· · · · · · · · · · · · · · · · · · ·			
		•						
		•	·	· · · · · · · · · · · · · · · · · · ·		<del></del>		
	•	TOTAL	·[	.90	7 (2.0)	<u> </u>	600	71) (25
			· I		LBS)	<b></b> J		4 ³ (FT ³ ) .
		- 4 - 4						,
	<u>s o L 1 D</u>		<u>ENDABL</u> ②		. ③	QUIRE	4)	(5)
<b>-</b> 445.5	<u>(</u>	) · (	₩T/UNIT (RI PKG.WT/UNIT	EF) )(REF)	WT/CYCLE ① X ② (LB)	(PKG. VC	INIT (REF) DL/UNIT)(REF) (FT³)	VOL/CYCLE ① X ④ (FT³)
TYPE N/A	UNITS/CYC	LE(REF)	(LB).		(rs)		(F13)	(117)
,		-						
<u> </u>		-		<del></del>				
		<del></del>		<del></del>	•		· · · · · · · · · · · · · · · · · · ·	
		<del>-</del>			·	· · · · · · · · · · · · · · · · · · ·		
	. <del></del>			<u>Σ</u> ③ _		•	$\Sigma$ (§	
			,		OTAL WT/CYCL	Ē		TOTAL VOL/CYCLE (FT3)
OTAL WT. = MISSION =		x		<b>X</b> .	•	-7		
CYC	LES/DAY	DAYS	NOISSIM	10	.WT/C/CLE (LB)			KG (LB)
OTAL VOL =		x		. х		<b>=</b>	.[	
CYC	LES/DAY	DAYS	MISSION	TO	.VOL/CYCLE (FT ³ )	_		M ₃ (FT ³ )
		•	•	•	. **		•	
1.0	<u>G A S/L</u>	<u> </u>	<u>E X P E</u>	N D A B L I	<u>s</u> <u>re</u>	<u>UIREM</u> !	<u>NIS</u>	
		①		RECOV		AMT. RECOVER	D/CYCLE	AMT LOST/CYCLE
ТҮРЕ		MT.USED/CYC	CLE(REF)	FACT		① X () (LB		①-③ (LB)
· N/A		•			,			· · · · · · · · · · · · · · · · · · ·
					·			
	-				<del></del>			
							-	
	$\Sigma$ ① .		,				$\Sigma$ $\bullet$	
	<b>~</b> • • •	<del></del>						,

SPACECRAFT_		Shutt1	le		·
HABITABILIT	TY SUBSYSTEM_	Personal	<u>Hygiene</u> HABITABIL	ITY FUNCTIO	N <u>Personal Groomin</u> g
APPLIANCE F	FUNCTION	Hair Cut	tting		
APPLIANCE (	CONCEPT NO./TI	ITLE 2/Ra	azor-Comb/Vacuum C	ollection	
INDEX NO	2.3.2.2		REF. NO.	236,207	
		•		•	

#### DESCRIPTION

The comb/vacuum collection concept consists of a razor comb with a hand-held vacuum pickup device. The concept requires two men to operate which is a disadvantage from the crew time aspect. The unit used for vacuum collection is the power module used on Skylab.



CONCEPT 2/PAZOR - COMB/VACUUM COLLECTION INDEX NUMBER 2.3. Z. Z ELECTRICAL POWER REQUIREMENIS POWER USE TIME (4)
DEMAND
(WATT-HR/
CYCLE)
(1) X (3) (7)
DEMAND
(WATT-HR/
CYCLE)
① X ⑦ **②** 3 (3) 6 CYCLE AVERAGE AVERAGE PEAK PEAK COMPONENT (REF) (HR) (WATTS) (WATTS) (WATTS) (WATTS) MUMIXAM TOTAL MUMIXAM TOTAL THERMAL  $\underline{R}\;\underline{E}\;\underline{Q}\;\underline{U}\;\underline{I}\;\underline{R}\;\underline{E}\;\underline{M}\;\underline{E}\;\underline{N}\;\underline{T}\;\underline{S}$ LATENT SENSIBLE HEAT LEAK TO COOLANT (BTU/HR) (BTU/HR) (BTU/HR) SOURCE (BTU/HR) TOTAL WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) WATT (BTU/HR) OPERATIONAL PENALTIES TUEDMA

•			KMAL	ELECTRICAL	WEIGHT	VOLUME	
•	SOURCE	HEAT LEAK (BTU/HR/CYCLE)	TO COOLANT (BTU/HR/CYCLE)	(PK WATTS/CYCLE)	(LB/MISSION)	(FT3/MISSION)	
11/0	•	•	•		•		
			• .		•		
				• • • • • • • • • • • • • • • • • • •			
	· · · · · · · · · · · · · · · · · · ·		*	Adaptament the second	•		
		1			· .	•	
	Τοτ/	MATTS/CYCLE (BTU/HR/CYCLE)	WATTS/CYCLE (BTU/HR/CYCLE)	•	KG/MISSION (LB/MISSION)	M³/MISSION (FT³/MISSION)	

# D2:418561;2

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 2/RAZOR-COMB/VACUUM COLLECTION

INDEX NUMBER Z.3.2.2

•	FIXED	MEIGH	INVOLU	ME RE	Q <u>U, I</u> <u>R</u> !	EMENIS	•
COMPONENT	·(REF)			NEIGHT (LBS)			VOLUME (FT ³ )
RAZOR COMB	/HULXX (236	<i>)</i> ·	•	1.5	· .		. 25
			-	,		1	
•			1				
			<del></del>	7-1-2-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-			
		•					
		•	· · · · · · · · · · · · · · · · · · ·			·	
	TOTAL	<b>\</b>		· 0	.5)		007 (25)
<i>,</i>	·	•	6	KG (LBS)	.3/	<u> </u>	$\frac{CC}{M^3 (FT^3)}$ ,
			••			•	,
	<u>SOLID</u> <u>EX</u>	PENDA	2	<u>I/V Q L</u> . ③ WI/CYCI		IREMENTS (4)	<b>(</b> 5)
TYPE	① UNITS/CYCLE(REF)	(PKG.WT/	T (REF) (UNIT)(REF) (LB).	WT/CŸCI ① X ② (LB)	)	VOL/UNIT (REF) (PKG.VOL/UNIT)(RE (FT ³ )	VOL/CYCLE (F) ①X④ (FT³)
N/A	DN113/CTCLE(REF)			(LB)		(F17)	(FI°)
· ·					• •		
•		****			·		
							_
		*	·				-
		•.	Σ3	TOTAL WT/	CYCLE	. \(\sum_{\sum}\)	TOTAL VOL/CYCLE (FT3)
	LES/DAY X D	AYS/MISSIO	N	TOT.WT/CYCLI	E		KG (LB)
TOTAL VOL	x		<u>x</u>			<u> </u>	
CYC	LES/DAY D	AYS/MISSIO	ON	TOT.VOL/CYCI	LE	<del></del>	M ₃ (FT ₃ )
				•	•		
1.1	<u>6 A S/L 1 Q U I</u>	<u>E</u> <u>X</u>	PENDAB		<u>E Q U 1</u>	REMENIS.	
TYPE H/A	· AMT.USED/	① CYCLE(REF) LB)		ECOVERY FACTOR	AMT.R	ECOVERED/CYCLE  ① X ②  (LB)	AMT LOST/CYCLE  (LB)
				•			
			•				•
**	Σ ①		_			Σ (4)	
	•		• .	•			,
TOTAL WT CYCLE	/DAY X DAYS/M1	SSION X	TOTAL LOST/	CYCLE .	(LB)	* <u>'t ()</u>	KG (LB)

## APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS

•	ELEC	TRICAL P	<u> 0 W E R</u>	REQUIRE	MENIS	
COMPONENT (REF)	USE TIME CYCLE (HR)	A C  PEAK (WATTS)	, POWE  AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) (D X 3)	D C  (5)  PEAK (WATTS)	POWER  (7)  (6)  DEMAN  AVERAGE  (WATT-H  CYCLE)  (WATTS)  (WATTS)
-N/A						
		-				
			• .	`	<del> </del>	
		· · · · · · · · · · · · · · · · · · ·				
*,						
	•	•	,			•
		MAXIMUM	• • •	TOTAL	MAXIMUM	, TOTAL
··.					•	
		. 3	• • •	•	•	
•	•	THERMAL	REQUI	<u>REMENIS</u>		•
		LATENT	•	SIBLE	HEAT LEAK	TO COOLANT
SOURCE	•	(BTU/HR)		U/HR)	(BTU/HR)	(BTU/HR)
·-N/A-						
				,		
			• 		•	
	<del></del>					-
``						
	TOTAL .	WATT (BTU/HR)	WATT	(BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)
•		•	•	,		
•		•.	•		•	
	,		•	•		•
,		<u> </u>	LAL PE	<u>NALTIES</u>		
SOURCE .	HEA (BTU/HI	THERMAL IT LEAK TO R/CYCLE) (BTU	COOLANT	ELECTRICAL (PK WATTS/CY		VOLUME ON) (FT ³ /MISSION
VACUUM POWER	2 ./	1.14.		115	.04	neg
						0

TOTAL

3,24 (11.14) NATTS/CYCLE (BTU/HR/CYCLE)

WATTS/CYCLE (BTU/HR/CYCLE)

.018 (.04) KG/MISSION (LB/MISSION)

M3/M1%10N (FT3/M1SS1UN)

HABITABILITY SUBSYSTEM_	2.0	Personal Hygiene	•	
HABITABILITY FUNCTION_	2.3	Personal Grooming		
APPLIANCE FUNCTION	2.3.3	Nail Care		
NUMBER OF CONCEPTS CONS	IDERED _.	2	1	•

#### **ASSUMPTIONS**

- (1) The nail care concepts considered are manual operations using bag and vacuum collection of nail clippings.
- · (2) The study assumed nail cutting once every 14 days.
- (3) Nail cutting is assumed to take 5 minutes per use.

## APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

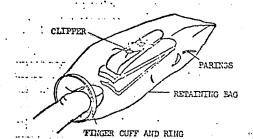
APPLIANCE FUNCTION: 2,3,3-NAIL CARE

					Νl	ИВ	E R	0	F	<b>C</b> 0	мро	ΝE	NTS	;		•		-
COMPONEN	TYPE	,					-							•		. ,		NUMBER OF SAFETY CRITICAL
APPLIANCE TYPE	NO.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	ITEMS
•						-											-	
			-			l NO	MECH/	NICAL	/ELEC	l CTRICA	AL COM	I IPONEN	TS					
																		-
•		-											·		-	-		
																		·
•	•												•					
								•									-	
		·					-											
•	• !			-														·
			!					,										·
•										,								

SPACECRAFT_	' 'Shut	tle		
HABITABILIT	Y SUBSYSTEM Personal	Hygiene HABITABILITY	FUNCTION Personal	Grooming
APPLIANCE F	UNCTION Nail Care			<del></del>
APPLIANCE C	ONCEPT NO./TITLE 1/	Manual Nail Clipper/B	ag Collection	
INDEX NO	2.3.3.1	REF. NO	236,207	
<del></del>			. — —	

#### **DESCRIPTION**

The manual nail clipper/bag collection concept consists of a terrestrial type nail clipper enclosed by a bag to contain nail clippings. The bag incorporates a finger cuff and ring to form a seal around the finger during nail cutting. The collection bag is transparent to observe nail clipping.



		ELECT	RICAL	<u>P Q W E R</u>	REQUIRE	MENTS	•	
	•			 C , POWE		D C	POWER	
COMPONENT . N/L .	(REF)	USE TIME  CYCLE  (HR)	PEAK (WATTS)	③ AVERAGE (WATTS)	DEMAND (WATT-HR/ CYCLE) ① X ③	⑤ PEAK	<u></u>	(7) DEMAN (WATT-H CYCLE) ① X (7)
			MAXIMUM		TOTAL	MAXIMUM		TOTAL
	•			•			•	
•		Ī	HERMAL	REQUI	REMENTS	. •	•	
\$ourc	E .		LATENT (BTU/HR)		SIBLE U/HR)	HEAT LEAK (BTU/HR)	ТО СО (вти	OLANT /HR)
<u>N/A</u>								
• •							****	
<del></del>						•		•
	,	· _					•	
-	· T	OTAL	WATT (BTU/HR)	. WATT	(BTU/HR)	WATT (BTU/HR)	WATT (	BTU/HR)
	1		WATT (BTU/HR)	WATT	(BTU/HR)	WATT (BTU/HR)	WATT (	BTU/HR)
	Ţ						WATT (	BTU/HR)
	ī	<u>o</u>	<u>P E R A T I O </u>	NAL PI	E <u>NALTIES</u>		•	
SOUF			PERATIO:  THERMAL LEAK			WEIGHT	VOL	BTU/HR)  UME
SOUF		<u>0</u> HEAT	PERATIO:  THERMAL LEAK	NAL PI	ENALIIE S ELECTRICAL	WEIGHT	VOL	UME

HATTS/CYCLE WATTS/CYCLE (BTU/HR/CYCLE)

B2-290

TOTAL

(LB/MISSION)

M3/MISSION (FT3/MISSION) APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT // MANUAL NAIL CUPPER / BAG COLLECTION INDEX NUMBER 2.3.3.1

•		WEIGHT		v	/OLUME
COMPONENT (REF) NAIL CUPPER/BAG (236		(LBS)		(	(FT ³ )
TANK CUTT LIQUING (200)	·				200
	-	•			***************************************
	· . <del>- · ·</del>				
	-		· · · · · · · · · · · · · · · · · · ·		
<b>T</b> otal	٠, ا	.145 (.	2:2	.000	
, IOIAL	• -	KG (LBS)	32)		02 (.00 <b>68</b> ) (FT ³ ) .
•				•	
<u>s</u> <u>o</u> <u>r</u> <u>i</u> <u>d</u> <u>e</u> x	PENDABL (2)		REQUIREM		(S)
0	@ WT/UNIT (F '(PKG.WT/UNIT	(1) (REF) (1) X (2)	.E VOL/UN ) (PKG.VOI	④ NIT (REF) _/UNIT)(REF) FT ³ )	VOL/CYCLE ① X ④ (FT³)
TYPE UNITS/CYCLE(REF)  COLLECTION BAG .0167 (236	(LB)	(LB)		555	(FT ³ )
· · · · · · · · · · · · · · · · · · ·					•
· · · · · · · · · · · · · · · · · · ·				<u> </u>	·
•					· · · · · · · · · · · · · · · · · · ·
		∑3 _00/67 TOTAL WT/0 · (LB)	ZYCLE -	Σ ⑤ _	100093 TOTAL VOL/CYCLE (FT3)
TOTAL WT. = .ZEC. X CYCLES/DAY D	ZO.5	x .00167	7=	.004	4 (.009)
·	DAYS/MISSION	TOT.WT/CYCLI (LB)	•	KG	(LB)
TOTAL VOL = 286 X CYCLES/DAY X	20.5 DAYS/MISSION	·х <u>0009</u> 5 Тот. VOL/CYCI	<u> </u>	.ax/	54 (005)
GIGLES/ DAT	M13/1113310M	(FT ³ )	-6	ri-	(F1-)
					•
<u>G A S/L I Q U I</u>		NUABLES R	EQUIREME		
TYPE AMT.USED/	① /CYCLE(REF) (LB)	RECOVERY FACTOR	AMT.RECOVERED ① X ② (LB)	)/CYCLE	AMT LOST/CYCLE  1 - 3 (LB)
N/A			•		
		•••••••	<u> </u>	<del></del>	
$\Sigma$ $\odot$ $_$		•		Σ@ _	
TOTAL WT. # XX	•	•	•	. F	
CYCLE/DAY X DAYS/MI	X NOT 221	L LOST/CYCLE (C (A))	<u> </u>		KG (LB)

SPACECRAFT	St	nuttle	•		
HABITABILI	TY SUBSYSTEM Perso	onal Hygiene	<b>HABITABILITY</b>	FUNCTION Personal	Grooming
APPLIANCE	FUNCTION Nail Ca	are .	·		
APPLIANCE	CONCEPT NO./TITLE_	2/Metal Nail	File/Vacuum	Collection	
INDEX NO	2,3,3.2		REF. NO	236,207	<del></del>
DESCRIPTIO	Ň	•	•	•	

The metal nail file/vacuum collection concept consists of a nail file with vacuum collection of nail filings. The file has a hood around the file to improve the vacuum collection efficiency. The concept is penalized for a vacuum unit based on operating time. The vacuum unit used is identical to the Skylab power module.

FILE PLUS FOR DEBRIS COLLECTION

# APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT 2/METAL NAIL FILE /VACUUM COLLECTION

. ...

INDEX NUMBER 2.3.3.Z

	ΕL	EC	IRICAL	POWE	<u>R</u>	<u> </u>	MENTS			
		•	·	C , P	OWEI	R		DC P	OWER	(
COMPONENT (REF)	CYC	TIME CLE (R)	② PEAK (WATTS)	AVER (WAT		DEMAND (WATT-HR/ CYCLE) ① X ③	⑤ PEAK (WATTS)	AVER (WAT		DEMAND (WATT-HR, CYCLE) ① X ⑦
			·					<del>-</del>		•
garanteep ( ) to the production of the control of t		·			<u> </u>			- ·		
			· · · · · · · · · · · · · · · · · · ·							
		·	· <u></u>	<del></del>	<del>,</del>					
particular and an accompany of the second se			•			*				,
			MAXIMUM	. •	٠,	TOTAL	MAXIMUM	· · ·	•	TOTAL
			•	•					-	•
			•	•	•				;	
			THERMAL	<u>R</u> E	QUIR	EMENTS				•
SOURCE		•	LATENT (BTU/HR)	•	SENS (BTU		HEAT LE (BTU/HR			COOLANT TU/HR)
N/A			•				-	•		
		•		<u> </u>				· 		******
	<del></del> -			<del></del>	<del></del>		<del> </del>			
<b>,</b>			Ty.	<del></del>	<del></del>	•			<del></del>	
	TOTAL		WATT (BTU/HR)	<del></del>	WATT (	BTU/HR)	WATT (BTU,	/up1	LIATT	(BTU/IIR)
			. •	••	mn	БТОУПКУ		, ,	MALI	(DIU/IIK)
	. •		•					•	•	
	٠		, ·			•		•	•	•
	•	٠	<u>O P E R A T I</u> (	O N A L	ΡF	N <u>ALTIES</u>		··		•
···			THERMA			ELECTRICAL		, , ,	°.	OLUME
SOURCE,	(		T LEAK R/CYCLE) (1	TO COOLA BTU/HR/CY	CLE)	(PK WATTS/CY		ISSION)		(MISSIM)
VACUUM POWER		_ · £	5.6		· .	115		02		heg .
MODULE (SKYLA						k	· · · · · · · · · · · · · · · · · · ·			• •
4								<del></del>		<del></del>
<u>}</u>										•
		·	1.64				.0	09	,	
TO	TAL	HAT	TS/CYCLE	WATTS/CY	CLE	115	(e ( KG/M	02) ISSION	M3/1	MISSION
		TRID	/IRK/CYCLE) . (	(BTU/HR/C	YCLE)		(LB/M	15510N)	(FT3/	(MISSION)

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

CONCEPT 2/MGTAL NAIL FILE/VACUUM COLLECTION INDEX

INDEX NUMBER 2.3.3.2

	,			WEIGHT (LBS)		,	VOLUME
COMPONENT FILE   HOOD	(REF) (23/		•	(LBS) /-Z			(F73) • 04
PICE, PICOD		ン 	• •				
		<del>-</del>					
				•			
						<del></del>	
		- ' -					
		<del>-</del> .	:	·			
		_ `			<del></del>		
							•
	TOTA	L	.54	14 (1.	<u>z)</u>	.0	
<b>r</b>			ı	KG (LBS)		,	M ³ (FT ³ ) ,
٠.,	<u>solid</u> <u>ex</u>	PENDA	RIF W			REMENTS	,
	30515 52			. 3 WI/CYCLE			<b>⑤</b>
	①	WT/UN (PKG.WT	② IT (REF) /UNIT)(REF)	(1) X (2)	<u>:</u> (F	VOL/UNIT (REF) PKG.VOL/UNIT)(REF (FT³)	VOL/CYCLE (FT ³ )
TYPE N/A	UNITS/CYCLE(REF)		(LB).	(LB)		(FT³)	(FT³)
<i>IX//D</i>							-
+							
•				•			
			<del></del>	•			
							• • • • • • • • • • • • • • • • • • •
			$\overline{\Sigma 3}$			- Σ@	
				TOTAL WT/CY	YCLE	•	TOTAL VOL/CYCLE (FT3)
TOTAL WT. =	X		X	•	=		· · · · · · · · · · · · · · · · · · ·
CYC	LES/DAY	DAYS/MISSI	ON	TOT.WT/CYCLE (LB)	<del></del>		KG (LB)
OTAL VOL =				(25)		.	
MISSION CYC	LES/DAY X	DAYS/MISSI	<u>ои</u> , х	TOT.VOL/CYCLE	Ē -	L	M ³ (FT ³ )
				(FT ³ )			
•							
	<u>G A S/L I Q U I</u>	<u> </u>	PENDAB			EMENIS	•
		①		© ECOVERY	AMT.RE	OVERED/CYCLE	AMT LOST/CYCLE
TYPE	. AMT.USEI	/CYCLE(REF	.,	FACTOR	•	① x ② (LB)	①-③ (LB)
N/A	<u>,</u>		<del></del>		•		
	· · · · · · · · · · · · · · · · · · ·					•	
		<del></del> -	· 			·	
<del></del>			<del></del>	<del></del>		Σ ④	
	- T					7 (4)	•
<u> </u>	Σ ①			•		20	3
	Σ ①			•		20	

## D2:118561-2

HABITABILITY SUBSYSTEM 2.0 Personal Hygiene			•	
HABITABILITY FUNCTION 2.3 Personal Grooming	····			
APPLIANCE FUNCTION 2.3.4 Teethbrushing	•	······································	<del> </del>	
NUMBER OF CONCEPTS CONSIDERED 3		•	•	

#### **ASSUMPTIONS**

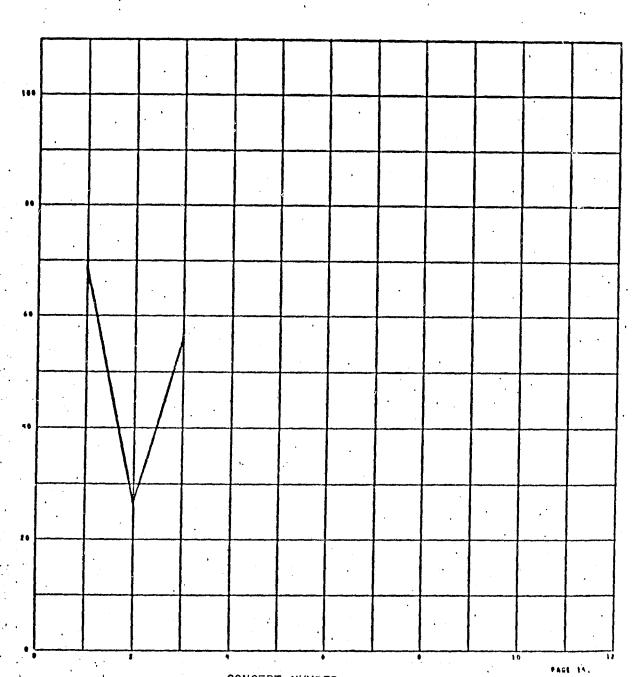
- (1) The dental concepts are manual and electric. Manual brushing and water flushing are the concepts considered by the study.
- ·(2) The study assumed four brushings per day per man.
- (3) Teethbrushing is assumed to take 5 minutes per brushing.
- (4) Dental floss is provided for each concept for cleaning the crevices of the teeth. Each crewman is supplied a number of 50-foot rolls of dental floss as determined by mission length. The usage is based on approximately one foot per day per crewman.

				<b></b>											• •
IHDEX	NU+ _2+3+4	••••. TEETH.	BKUSHING	(SHUT IL	E)										
CONCEPT	T USAGE TIME	COMSUMABLES	AND FLOY	A BEARINE	HENTS	THER	MAL RE	NTS	ELEC PM	R REGM	S WT/YOL I	REOMTS	DE FELOPMENT COST	RESUP	PLY
	HRS/USE	AMT. TYPE USED	•.	-MMHG-	-DEG C-	-AATT	5 <b>-</b> -+	1775-	DC	ـــــــــــــــــــــــــــــــــــــ	#E1GHT +kG+	-cu m-	(**) (***)	−KG	-
*****	******	(L8/USE)		. [PSIGI.	DEG F}		R) (61)	2/HR}	-#ATTS-		(L85) - (	(CU FT)	•••••	(LB	5 }
		<del></del>	· · · · · · · · · · · · · · · · · · ·		· 		: , ,	- 0•	•0	•o-	( 14+0)		· · · · · · · · · · · · · · · · · · ·	(	•0~
2	16.000	5 •0567 (•1250)4		1551+4 (30+0)	21+1	( 6		8 • 27 • }	24.0	•6	1 • 2	•60			•0;
	-16-000 -082					( .0	-	7+1	• 0 • 0 • 0	•0	5.9	• 37)	-110	(	•0-
APPLIAN CONCEP			•	<del></del>				(*						•	
NO.	с 0	NCEPT N		•	<u> </u>			····	1 - CABIN 2 - CABIN 3 - OXYGEN	AIR {	(LOST)	KG/HR KG/HR	(LB/HR) (LB/HR)		
3	- NATER	PIX RIC TOOTHERUSH			Poor (	ORIGIN.		· · · · · · · · · · · · · · · · · · ·	4 - COOLIN 5 - WATER 6 - NITROG 7 - NITROG 8 - FREON	GEN GEN	(CIRCULATED).	, KG/HR , KG/HR , KG/HR	(LB/HR) (LB/HR) (LB/HR) (LB/HR) (LB/HR)	<u> </u>	
						AL P			9 - WATER		(PROCESSED)	KG/HR	(LB/HR)		
					QUALLIA	AGE			(**) <u>AVAI</u>			(***)COS INDIC	ATOR	•	
		<del></del>	·		R	75	<del></del>	-	<ol> <li>AVAILABL</li> <li>STATE OF</li> </ol>		•	0-2 25-5			
								•	L, 01/11/L 0.						

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# D2-11856F2

APPLIANCE CONCEPT				 	 	·	 
. NO.	С	٥	-		N		E
1 -					DENT		CE
2							 



CONCEPT NUMBER

Dental (Shuttle) Concept Trade

B2-298

APPLIANCE CONCEPT COMPONENT SUMMARY MATRIX

APPLIANCE FUNCTION: 2.3.4-TEETH BRUSHING

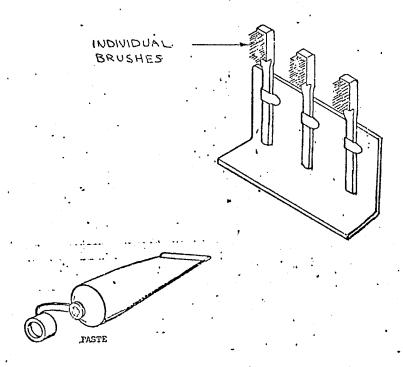
	<del></del>			JMB	E R	0	F	C 0	мРС	N E	NTS	<u> </u>	<del></del>			
COMPONENT TYPE	(MOTOR	CONTROLLER .	ELECTROACOUSTIC TRANSMISSION	IGH FREQUENCY ONTROLLER							•	•				NUMBER OF · SAFETY CRITICAL
APPLIANCE TYPE NO.	1 2	) 19	15	1	0	0	0	0	0	0	0	0	0	0	0	ITEMS
TOOTHBRUSH WITH DENTIFICE WATER PIX ELECTRIC TOOTHBRUSH WITH DENTIFICE ULTRASONIC CLEANING DEVICE		1 -	1	1			•				-		•			0 0 1
										_						•

D2-118561-2

SPACECRAFT	<u> </u>	huttle .	
HABITABIL!	TY SUBSYSTEM Persona	l Hygiene HABITABILIT	Y FUNCTION Personal Grooming
APPLIANCE	FUNCTION Teeth	Brushing	
APPLIANCE	CONCEPT NO./TITLE	1/Toothbrush with Der	ntifrice
INDEX NO.	2.3.4.1	REF. NO.	236

#### DESCRIPTION

The toothbrush with dentifrice concept consists of a terrestrial type toothbrush with dentifrice. The dentifrice is digestible to be nonhazardous if accidentally swallowed and is dispensed by a roll-up tube. Mouthwash is also provided in a soft plastic "squeeze bottle." One squeeze bottle per each crewman is provided for hygiene reasons. The mouthwash is used to mix with the dentifrice and is expectorated into a sink or fecal collector. This concept has flown on Apollo.



# D2-118561=2

CONCEPT TROTHBRUSH WITH DENTIFELICE.

APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS INDEX NUMBER 2.3.4.1

· · · · · · · · · · · · · · · · · · ·	ELECI		<u>P Q W E R</u>	REQUIR		•
COMPONENT (REF)	USE TIME CYCLE (HR)	2) PEAK (WATTS)	C . POWE  AVERAGE (WATTS)	DEMAND (HATT-HR/ CYCLE) ① X ③		POWER  (DEMAND AVERAGE (WATT-HE CYCLE) (WATTS) ① X ⑦
•		MUMIXAM	·	TOTAL	MAXIMUM	TOTAL
	•	•	,		•	
	• 1	<u>[ H E R M A L</u>	<u>R E Q U I</u>	<u>R E M E N T S</u>		
SOURCE		LATENT (BTU/HR)		SIBLE U/HR)	HEAT LEAK (BTU/HR)	TO COOLANT (BTU/HR)
N/4		•	•	•		
			-			
					*******************************	-
1	TOTAL _	WATT (BTU/HR)	· WATT	(BTU/HR)	WATT (BTU/HR)	WATT (BTU/HR)
•	٠			•		
	. 0	<u> P E R A T I O</u>	NAL PE	NALTIES	•	•
	HEAT	THERMAL LEAK T	O COOLANT	ELECTRICAL	. WEIGHT	VOLUME
SOURCE N/A	(BTU/HR/	. (BT	U/HR/CYCLE)	(PK WATTS/CY	CLE) (LB/MISSION	) (FT ³ /MISSION)
	-					
101	WATTS	/CYCLE W. R/CYCLE) (B'	ATTS/CYCLE TU/HR/CYCLE)	·	KG/MISSION (LB/MISSION	M³/M15510N (FT³/M15510N)

B2-302

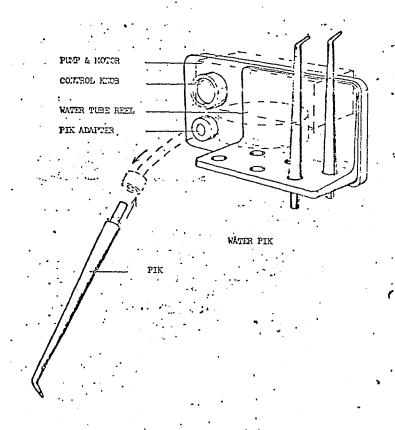
## APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED) CONCEPT 1/TODTH BRUSH WITH DENTIFRICE INDEX NUMBER 2.3.4.

OMPONENT	:	(REF)		•	WEIGHT (LBS)			, V	OLUME FT³)
TOOTH BRUSH	)	(236	).	·	1.85		• • •	' ' '	.9
				•••	16.5				.33
	·			•	•				
				•		•			
				<i>;</i>					
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				,	45 (1	7.51	<del></del>		
		TOTAL		6	.42 (1 KG (LBS)	4.15)	1	.035	(FT ³ ) .
		-		.•		. •		*	
	<u> </u>	<u>E X 1</u>	PENDA	<u></u>	MI\C.	3) R E Q U I	REMEN VOL/UNIT PKG. VOL/UN (FT ³ )	<u>I S</u>	<b>(5)</b>
TYPE	· ( UNITS/CY	() E(DEE)	WT/UI (PKG.W	NIT (REF) F/UNIT)(REF (LB).	*) WT/C' *) ①x	CLE (CLE)	VOL/UNIT PKG.VOL/UN	(REF) IT)(REF)	VOL/CÝCLE ①X ④ (FT³)
DENTIPRICE!	UN115/C1			(LD).	(LI) 2037	31 75 (234)	(F12) 		_001 (
NOUTHWASH					<del></del>				
					<del>-</del>				
		<del>,</del>							
					_	-			
				$\Sigma$	3 _037 TOTAL W	75 T/CYCLE	· ·	Σ⑤	TOTAL VOL/CYCLE
OTAL WT. = /	6	X	20.5 Ys/MISS	5 x	.037	~' <b>~</b> =	Γ-		
CYCL	ÉS/DAY	D/	YS/MISS	ION	τοτ. Wτ/cΥζ (LB)	ΣĹΕ	,	5.58 KG	(LB)
TAL_VOL =	ES/DAY	_ x	20.5	5x	.001	.=	· [	.009.	3 (.32)
CYCL	ES/DAY		AYS/MISSI		TOT.VOL/CV (FT ³ )	YCLE .		M3	(FT ³ )
•	,	• .			•			•	
	<u>G A S/L</u>	<u> </u>	<u>E 2</u>	K P E N D !		REQUIR	_	•	
	•		① CYCLE (REI	=1	@ RECOVERY	AMT.RE	COVEKED/CYO	CLE	AMT LOST/CYCLE
TYPE A//A	• •	AMT.USED/0	В)	,	FACTOR		①x② (LB)		① - ③ (LB)
				<del></del>	1				
· · · · · · · · · · · · · · · · · · ·	<del></del>	<del></del>		<del></del>	<u> </u>	<del></del>			
·	$\sum 0$			<del></del>		<del></del>	2	<u> </u>	<del></del>
	1111							<i>-</i>	

SPACECRAFT_	'Shutt'	<u>le</u>		
HABITABILIT	Y SUBSYSTEM Personal	<u>Hygiene</u> HABITABII	_ITÝ FUNCTION	Personal Grooming
APPLIANCE F	JNCTION <u>Teeth Brus</u>	shing ·		
APPLIANCE C	ONCEPT NO./TITLE	2/Water Pix		
INDEX NO	2.3.4.2	REF. NO.	236,207	
				·

#### DESCRIPTION

The water pix concept is the same as the terrestrial type. One unit is provided with individual tips for each crewman. The unit is plumbed with water and wired electrically for power. The water pix creates á high velocity spray which is directed at the tooth crevices to loosen debris. The water is collected in the mouth and expectorated into a sink or fecal collector. The water is assumed to be recoverable by the study with the exception of the water loss due to suspended solids.



**D**2-11856

7/2

CONCEPT 2/WATER P	APPLIAN	ICE CONCEPT RI	EQUIREMENT	S AND PE	NALTIES CALCU	JLATIONS .	NDEX NUME	BER 2.	3.4.Z
	ELECT	RICAL.	POWE	<u>. r</u> <u>r</u>	<u>LEQUIRE</u>	MENIS			
			A 'C . P		•		D C	POWE	R
COMPONENT (REF) WATER PUMP (216)	USE TIME CYCLE (HR)	② PEAK (WATTS) 24	AVER		DEMAND (WATT-HR/ CYCLE) (DX(3)	DEAK (WATTS)	-	⑥ /ERAGE /ATTS)	DEMAND (WATT-HR, CYCLE) (1) X (7)
		•• •	-	`					,
							_	•	
*		·		<del></del> .					
	•	24		•	2.0			.•	
		MUNIXAM	· .	•	TOTAL	MAXIMU			, TOTAL
•	•			•		•		:	•
		THERMAI	<u>R E</u>	QUIR	EMENTS				•
\$ SOURCE		LATENȚ (BTU/HR)	•	SENS!		HEAT I			COOLANT BTU/HR)
MOTOR		•	•		7		7		•
	•		·						
							· ·	4 	
<b>A</b>	TOTAL.	MATT /DTU/U			(27)	7.9			
		WATT (BTU/HE	· .	WATT (E	то/нк)	WATT (BI	U/HK)	WAT	T (BTU/HR)
	•						•		•
	0		ONAL	PEI	LALIIES		٠.		•
SOURCE.	, HEAT	THERM	•		ELECTRICAL (PK WATTS/CYC	1	MEIGHT /MISSION)		VOLUME (3/MISSION)
N/A			······································	, • .			. • ·		
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								_	
						<del></del>			حجمنية فسيحسي

· B2-305

WATTS/CYCLE (BTU/HR/CYCLE) (EL3/WISSION)
W3/WISSION

KG/MISSION (LB/MISSION)

TOTAL

WATTS/CYCLE (BTU/HR/CYCLE)

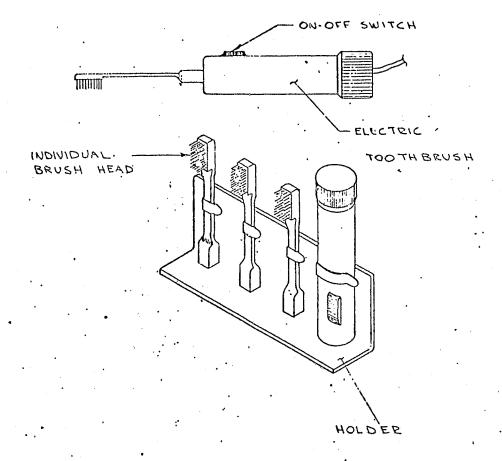
	APPLIANCE CON	CEPT REQUIREMENTS	AND PENALTIES	CALCULATIONS				
CONCEPT 2/WATTE	PIX				INDEX	NUMBER Z	3.4.	<u> </u>

COMPONENT		(REF)	•	WEIGHT (LBS)	,	•	VOLUME (FT3)
WATOR PIX	7257	(236)	• •				0924
				,			
		-					
			•		·		
	•		· · · · · · · · · · · · · · · · · · ·		·		
		TOTAL .	1.2	2 <i>3</i> (2.72 kg (lbs)	<b>1</b> 1	.00	Z6 (0929. 3 (FT3) ,
•	<u> </u>	EXPEND	 ABLE W	I/VOL RE	<u>Q U I R E M</u> .	ENTS	· ,
	<b>(</b> D		② NIT (REF) T/UNIT)(REF)	, ③ WT/CYCLE	VOL/UN	④ IT (REF) /UNIT)(REF)	VOL/CYCLE
TYPE · N/A	UNITS/CYCLE	(REF)	(LB).	①x② (LB)	(FKG. VOL (F	73)	① X ④ (FT³)
	•			•			•
	<u> </u>						
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			Σ3				
,		,	20	TOTAL WI/CYCLE · (LB)		$\sum$ (5)	TOTAL VOL/CYCLE (FT3)
OTAL WT. =CVC	LES/DAY X	DAYS/MISS	X	TOT.WT/CYCLE	=		G (LB)
	·	UNISTRISS	100	(LB)			( ( ( )
OTAL VOL = CYC	LES/DAY X	DAYS/MISS	ION .X	TOT.VOL/CYCLE (FT³)	. •	· M	3 (FT3)
				(F(*)	•	•	• ·
	<u> </u>	S N T D E	<u> </u>		<u>UIREME</u>	<u>N T S</u>	* *
	. AUT	① .USED/CYCLE(RE	c) / R	ECOVERY	MT.RECOVERED ① X ② (LB)	/CYCLE	AMT LOST/CYCLE
TYPE WATER	<i>M</i> 11	(LB) .125 (Z.	. 1	FACTOR	(LB) 		①-③ (LB) .125
<i>—</i>							
			<del></del>				•
· }	Σ ①	.125				Σ ④ _	.125
OTAL WI /4		_	•	_	•		18.6 (41)

SPACECRAFT		Shuttle		
HABITABILI	TY SUBSYSTEM Person	nal Hygiene	_HABITABILITY	FUNCTION Personal Grooming
APPLIANCE	FUNCTION Teeth	Brushing'		
APPLIANCE	CONCEPT NO./TITLE_	3/Electric	: Toothbrush w	ith Dentifrice
INDEX NO	2.3.4.3		REF. NO	236,207
	•	•	•	

#### DESCRIPTION

The electric toothbrush with dentifrice concept consists of a motor-driven toothbrush with individual brushes for each crewman. The same dentifrice and mouthwash used for Concept 1 are utilized for this concept. The vibratory action of the toothbrush has the advantage of massaging the gums as well as cleaning the tooth. The unit is wired electrically to provide power to the unit.



### APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS CONCEPT 3/ELECTRIC TOOTHBRUSH WITH DENTIFRICE

INDEX NUMBER 2.3.4.3

	ELEC	IRI,C·AL	<u> </u>		REQUIRE		D C P	OWER	
COMPONENT (REF) MOTOR (236)	USE TIME CYCLE (HR)	② PEAK (WATTS) - 6.0	AVERJ (WAT	3) AGE	(4) DEMAND (WATT-HR/ CYCLE) DX3	⑤ PEAK (WATTS)		6) AGE TS)	DEMAND WATT-HR CYCLE) (1) % (7)
		-		•	*				3
	•								•
	ě	.6.0 MAXIMUM.	· .	·	TOTAL	MAXIMUM .	. · ·		TOTAL
	•	<u> </u>	<u>L RE</u>	Q <u>U I R</u>	<u> </u>	. •	· · · · · · · · · · · · · · · · · · ·		
SOURCE		LATENT (BTU/HR)	•	SENSI (BTU/		HEAT LEA (BTU/HR)		то со (вти	
MOTOR	· .	•		6.	75	6.75	<u>:</u>		
			· ·			***************************************	(		
<b>\</b>	TOTAL	NATT IDTUM			(6.75)	1.98 (6			
•	•	WATT (BTU/H	к)	WATT (B	10/нк)	WATT (BTU/	HR)	WATT (	BTU/HR)
			•				•		
SOURCE.	HEA	OPERATI THERM TLEAK R/CYCLE)		, NT	ELECTRICAL (PK WATTS/CY	WÉ	IGHT ISSION)		.UME 115510N)
- N/A -				•••			· 		
		•							·
	TAL WAT	TS/CYCLE /IIR/CYCLE)	WATTS/CYC	CLE YCLE)		KG/M (LR/M	ISSION ISSION)	M3/WI	\$\$10H (NO12S1

B2-308

### APPLIANCE CONCEPT REQUIREMENTS AND PENALTIES CALCULATIONS (CONCLUDED)

a the definition of the first that the first t	
CONCEPT_3/ELECTRIC TOOTHBRUSH WITH DENTIFICE	INDEX NUMBER 2.3.4.3

	<u>FIXED</u>	WEIGHT/V	OLUME RI	<u>EQUIREM</u>	<u> </u>	
OMPONENT FLECTRIC TOOTH	(REF 1 <i>RPUSHA</i> Y23	) 6)	WEIGHT (LBS)			YOLUME (FT3) 0425
ENTIFRICE/MI	OUTHWASH (Z.	36)	12.3	*		328
			**************************************			
		- 1				
						,
	. <b>t</b> ot <b>a</b>	`	5.9 ( KG (LBS)	(13.0)	.010·	4 (3705) (FT ³ )
	<u>SOLID EX</u>	PENDABL.		REQUIR		,
TYPE	① UNITS/CYCLE(REF)			(2) (PKC B)	(A) DL/UNIT (REF) G. VOL/UNIT) (REF) (FT ³ )	(5) VOL/CYCLE (1) X (4) (FT³)
DENTIFRICE / MOUTHWASH				75 (236) <u> </u>		.00/ [23
						*
					-	
•		•	∑33. TOTAL WI	T/CYCLE B)	Σ ⑤ _	10TAL VOL/CYCLE (F13)
OTAL WT. = /G MISSION = CYCLE	S/DAY X	20.5 DAYS/MISSION	x .0375		5.58	
MISSION = CYCLE	S/DAY X	20.5 DAYS/MISSION	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXX XXX XX X XX	YCLE		93 (-328)
•	•	,		•	•	•
	GAS/LIQUI		NDABLES · ②	<u>R E Q U I R E</u>		4)
TYPE - N/A -	AMT. USED	① /CYCLE(REF) (LB)	RECOVERY	AMT.RECOV	(3) VERED/CYCLE X (2) (LB)	AMT LOST/CYCLE  1 - 3 (LB)
						•
,	$\Sigma$ $\odot$				ΣΦ	
DIAL WT.			•	•	<u>.</u> 1-	· ,
CYCLE/D	AY DAYS/M	ISSION X YOTA	L LOST/CYCLE -	(LB)	· · · · · · · · · · · · · · · · · · ·	KG (LB)